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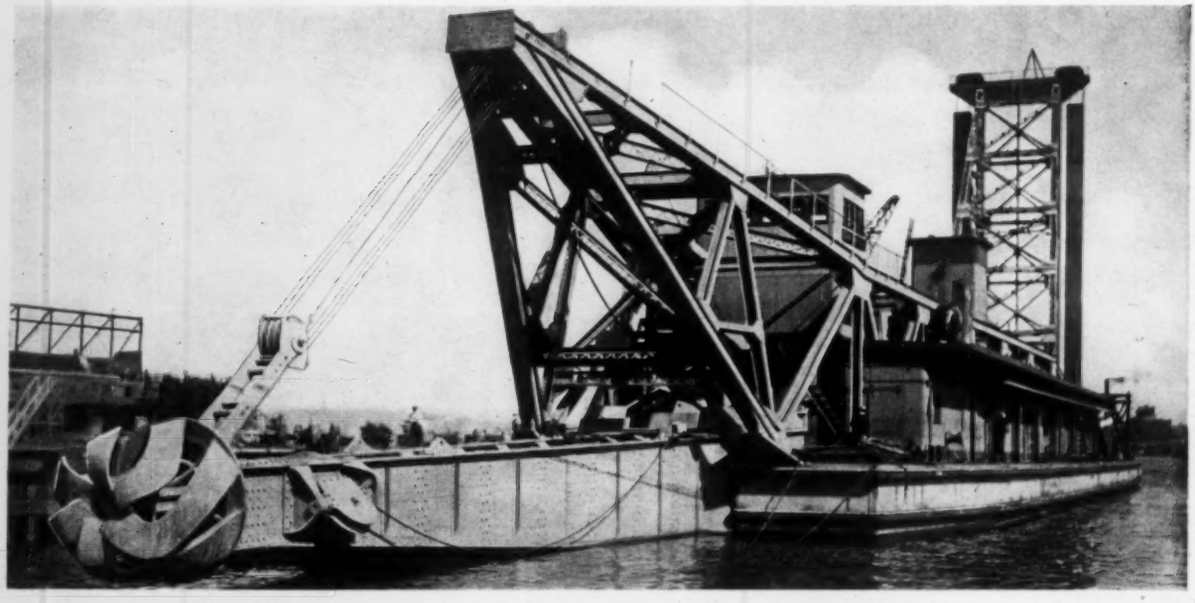

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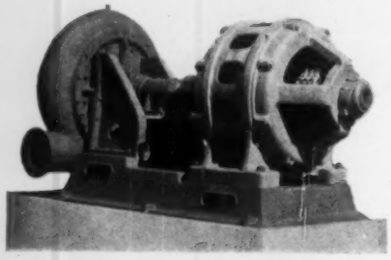

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The Low-down on Upkeep

REMINGTON RAND INC.

SYSTEM SERVICE DIVISION
EIGHTH FLOOR BARTHOLOMEW BLDG.
205 EAST 42ND STREET
NEW YORK CITY

January 5, 1933.

Water Works Engineering
24 West 40 Street
New York, N.Y.

Attention of Mr. Fred Shepperd, Editorial Director

Gentlemen:

We have made an analysis of the questionnaires covering pipe maintenance and are pleased to submit our findings as follows:

1 - Completed questionnaires were received from 195 Water Departments throughout the United States.

2 - Of these 195 definite replies, we find that 6 reported maintenance costs for Material A, 35 for Material B, 192 for Material C and 36 for Material D.

3 - For these four kinds of pipe we have listed in a summary on sheet attached the total cost per mile per year in all cities reporting for each different type of pipe. Key to the designations for each kind of pipe will also be found on attached sheet.

4 - We have also listed for the four types of pipe the number of cities reporting "no cost".

5 - Our findings show that the cost of maintenance per mile per year was $38.50 for Material A, $62.54 for Material B, $12,48 for Material C and $43.79 for Material D.

Yours very truly,
REMINGTON RAND, Inc.
Geo B Ramsey
Manager
Analysis and Indexing Service

G.B.Ramsey/t

Material "C" is

CAST IRON PIPE

(Permission to reprint the above letter is gratefully acknowledged by The Cast Iron Pipe Research Association, Thos. F. Wolfe, Research Engineer, 309 Peoples Gas Building, Chicago, Ill.)

ALONZO J. HAMMOND
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MARCH 1933

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VOLUME 3 NUMBER 3

International Relations

An Analysis of World Events and Their Effect on the Economic Depression

By FRED I. KENT
DIRECTOR, BANKERS TRUST COMPANY, NEW YORK, N.Y.

WHAT conditions caused the depression? What can we do to restore business to its normal condition? Mr. Kent, a prominent New York banker and an officer of the American Bankers Association, presented his views on these plaguing questions before the Annual Meeting of the Society in New York on January 18, 1933. In his paper he made a step-by-step analysis of the international relations and national conditions that he believed responsible for our present difficulties.

He is the author of the Kent Plan, which contemplates that government temporarily insure private industry against loss on a sound insurance basis if it will reemploy men and enter into normal production. The application of the plan, however, is to be carried out only after a survey of industry that will enable it to be applied to a proper series of industries, based on existing conditions. His plan of insurance guarantees to selected industries, through the Reconstruction Finance Corporation, will, he believes, reestablish business on a normal basis. For undertaking the guarantees, the Reconstruction Finance Corporation would receive half the profits of the industries concerned, which would prevent the continuation of the plan after conditions began to approach normal, as industries would then prefer to take their own risk rather than to accept guarantees against half of their profits.

EXCEPT through accident, no problem can be solved unless all the elements necessary to its solution are recognized, allowed for, and understood. Therefore, in every problem that has to do with human relationships, the actual characteristics of mankind and the direction and relative force of the activities that may result from them must be taken into account before a logical solution can be reached. The variables arising through inability to measure definitely the latent human forces that may be aroused through the development of any particular set of circumstances, necessitate a tremendous amount of experimentation. This is also true of most problems connected with the applied sciences, but the methods of investigation are different. Research in science and mechanics accepts the known as the basis on which progress must be made, even while recognizing the limitations of this basis. Close study of the atom, first accepted as the primary quantity in an element, revealed that it is a little world in itself, the component parts of which require further study to disclose their secrets. The locomotive of today is the result of the creative ideas of several generations, all built up on knowledge previously obtained.

But in building theories for the operation of government, the lessons of the past are largely forgotten and the known forces that govern human activities are ignored. This is true partly because of the many variables that enter into the problem, but more especially because the desire of the moment is stronger than the willingness to make a present sacrifice for long-time advantage. Trends are determined by the multitudes, who are more susceptible to the wiles of unintelligent or vicious so-called reformers than to the less sensational efforts of those who are striving to find the way to sound progress.

Again, historians have not brought together the lessons of past periods with any degree of effectiveness so that they can be visualized by the great mass of the people. The constant repetition, through generations, of the movement of the untoward forces that lie within a democracy has never been so set forth as to make it impressive even to students of history. What, therefore, can be expected of the people as a whole?

The failure of money inflation to benefit a nation, as exemplified in Germany and Austria, where terrible hardships have been caused by such inflation, apparently carries no lesson to vast numbers of people in this country. Government operation has been a failure throughout the world, wherever tried, with the few exceptions that prove the rule, yet we as a people are letting it grow upon us in spite of our knowledge of this fact.

The disintegration of governments of all kinds under excessive taxation, throughout the history of mankind, seemingly carries no lesson to this present generation any more than it did to any preceding generation. The failure of paying out doles by governments for no work accomplished to bring about better conditions is seen in our own time in several important countries of the world, and yet it carries no lesson to us and we are now considering the possible introduction of the same system.

In this country we have developed a capital-gain tax which increases the receipts of government during times of prosperity, when they are not needed. This

results in legislation launching projects which require the same high rate of expenditure during times of depression when the income of the government from the tax is tremendously reduced, along with all other taxes.

Do we learn anything from this trying experience even while we are living through it? No! Instead, we make the tax more harmful and dishonest in its application by taxing capital gains but not allowing a commensurate deduction for capital losses. When another extended rise in the price of commodities, real estate, and securities takes place, a part of the urge to sell will be gone and prices will have a tendency to go even farther above proper levels than they did in 1929. In the meantime, many individuals will be paying taxes on income when they have suffered net losses, and these levies will thus constitute a tax on their capital although the rest of the community is not so taxed.

INDUSTRY DISRUPTED BY THE WAR

The depression through which we are passing has its normal cyclical phase. This normal movement, however, has been greatly aggravated by a few important human activities that could have been controlled if they had been recognized in time. It might be helpful to a better understanding of present conditions in the United States and in other countries to focus attention for the moment on the series of developments that took place after the close of the War and undoubtedly lie back of our present troubles.

The greatest force for evil, in so far as its cumulative effects are concerned, can be traced back to the acts of European governments following the War, that were aimed to protect returning soldiers who could find no work.

After people have had a holiday, whether for a day or for several days, they return each to his regular position in the business world, and the wheels of production and commerce start turning where they stopped. Following the Great War, the people still desired all the commodities formerly produced. If every one had been returned to the work he did before the War, and the vacancies caused by the War had been filled from the generation that had grown up during the conflict, the situation would have been almost identical to that following a holiday.

If, following the War, the European nations instead of paying men for doing nothing, had used the collective power of government to insure industry against loss while it undertook normal production and employed the men required to do so, there need have been no currency inflation. There need have been no creation of government loans on a false basis; there need have been no trade barriers put up to destroy the international exchange of goods; there need have been no maladjustment of gold reserves between nations. The whole series of unfortunate governmental acts that led to the present intensification of a normal cyclical movement need never have occurred.

After the War, the finances of the governments of the warring and neutral nations of Europe, while evidencing the disastrous effects of the conflict, were still sufficiently strong, considering the taxing power of government and the wealth that remained in the hands of the people, if soundly utilized, to furnish the base for an immediate rebuilding of the business and financial structures of Europe. There was great disruption in all industries because many whose products were only needed, or could only be consumed, in times of peace, had stopped normal production owing to the diversion of men into war activities.

Industries in all countries of the world found their markets cut off through war needs. This loss in demand threw men out of employment, and in the warring nations, the returning soldiers were added to the ranks of those who had lost their opportunity to work. Governments developed various means of meeting this unemployment situation, practically all of which resulted in paying men for doing nothing. The widespread idleness that prevailed, together with the depletion by war of the goods required for normal living, created a tremendous demand for production during 1919.

EUROPEAN IMPORTATION INCREASED

This demand, instead of being filled through the employment of the idle men in European countries, was met by importations from the rest of the world, in particular, from the United States. Payments for such importations, not being possible through an exchange of goods because of this extended idleness, were met by the establishment of credits and loans. The demand was so great and caused such a rush of production throughout the world to meet it, that there was an unnatural and abnormal rise in commodity prices, reaching its peak during the summer of 1920.

The strain of excessive importation caused the European countries to increase the trade barriers between one another, which had in part been established from fear of the effect of the peace treaties. In many of these nations, inflation developed due to weakening of government finances, because the payments being made to men who were giving no return in work could not be recovered from taxation. The tax burden on the industries that were still functioning was already too great.

Returning soldiers in particular required work to aid them in the recovery of their mental balance, which had been so disturbed by the War. Work was not available and therefore they were paid for doing nothing. The result was that great unrest developed among them and among other unemployed groups in all countries. This unrest brought pressure on governments to make expenditures for various so-called social services which increased the strain on their finances. Governments floated loans, internal and external, the proceeds of which were unwisely used for current expenditures, instead of to create a financial base that would develop tax-producing wealth as time went on to meet the debt charges.

Inter-Allied debts and reparations acted as psychological and financial brakes to prevent the resumption of the former amicable relations between nations and the return of sound business progress. As a result of the great inflation in Germany in 1923, the Dawes Plan was worked out and put in force in 1924. Throughout the period men were being paid for doing nothing in various ways in many countries.

UNEMPLOYMENT IN EUROPE CAUSED PRICE INFLATION

From 1924 to 1929 there was a certain important reconstruction of the industrial structure throughout Europe, but during the whole period there was so much unemployment that much of the goods required by the European peoples, which the idle men could have produced if they had been given employment, had to be imported. Also because of this unemployment, the European nations were unable to produce surpluses of their own products to pay for imports. The result was that to a great extent European nations were importing goods against loans made in America. Other countries outside of Europe were also borrowing in America to

obtain goods which they wanted partly to fill vacuums created by the War, and partly to meet growing developments.

Movements of gold became erratic, so that many nations were not able to keep their gold reserves in line with their indebtedness. This was because in many countries men were not producing but consuming at the expense primarily of their governments—actually at the expense of the peoples on whom the burden of taxation fell. This whole movement, with cumulative force derived primarily from the growth of payments to men for doing nothing, caused a great increase in American production and trade, attended by the inevitable speculation that follows false stimulation. This speculation in America attracted from many other countries funds that were idle in part because men were idle and the money could not be employed in industry. The resulting accelerated speculation in the United States was not confined to securities but reached into the fields of construction, of trading in commodities and real estate, and into almost every other form of endeavor.

This process had to have an end. It came in the fall of 1929. Security prices, commodity prices, and values in real estate began to crumble, and the whole false structure built on the base of government-supported idleness was destroyed.

AMERICAN UNEMPLOYMENT FOLLOWS CRASH

Evidence of the unsound industrial situation was first brought to the attention of the world in the spring of 1931 in Austria. If the industrial structure had only been unsound in that little country, the disastrous condition could not have spread throughout the world as it then did. The Austrian development was merely one manifestation of a world-wide condition that had killed international trade. The tax burdens on industry had so increased that progressive unemployment had started.

The world then found itself face to face with facts that had long existed without being realized and which, translated, meant simply a vast debt structure, internal and external, in nearly all nations. Governmental budgets could not be met from the proceeds of industry when millions of men were unemployed. Legislation throughout the countries of the world had been created through the pressure of organized minorities, backed by forces traceable primarily to the unrest of men who were being paid for doing nothing.

Meantime, in the United States there was growing unemployment due to the fall in prices of commodities, real estate, and securities, and the inability of foreign countries to buy because they were denied credit in this country, and were unable to produce goods for exchange. Thus an enormous burden was placed on our national income. To meet excessive taxation and furnish the unemployed with the means to live, the capital that otherwise would have been utilized in large part for the furtherance of industrial enterprises, was destroyed. Growing demands by the people of the United States, as well as those of other countries, for reduction of excessive governmental expenditures of all kinds, were met in most cases by increased taxation. This was because the demands for the expenditure of money were recognized by legislators in preference to demands for decreased taxation. Further legislation already in force required continued expenditures at the high level of the previous period.

Agitation in America, both in the states and in Washington, for laws that would require the government to undertake various forms of payments to the unemployed for doing nothing, if allowed to prevail, will mean the further extension of the wave of unwise governmental activity which is at the bottom of most of the important barriers to industrial and trade recovery. If any of these schemes are made into law we must expect the same unfortunate developments in this country that have followed the passage of such acts in every country where they have been tried.

BAD EFFECTS OF UNEMPLOYMENT DOLES

No one would advocate withholding aid from men who, through no fault of their own, are unemployed. For humane reasons and for the good of the people themselves, sound protection should be afforded the unemployed under such circumstances. There is no question but that the emergency of unemployment should be met by the people in case of catastrophes of temporary effect, and by the government if the condition is sufficiently widespread and long-continued to warrant it. The payment of men for doing nothing, however, is not only the wrong way to meet such an emergency but is also the sure way to initiate a series of progressively harmful developments. It is unfair to the men receiving the payments because it kills happiness, breeds discontent, and develops a non-working complex. As a result of such unrest, pressure is brought to bear on governments to make unwise expenditures. A way is opened to the most vicious political forces to gain headway, leading to favoritism, increased governmental expenditure and waste, and the building up of power in the wrong places. Such political power, exercised progressively, leads to excessive taxation and this in turn bears down on industry and causes further unemployment. The problems of the nation become so complicated, with various forces working at cross purposes, that life for the individual is increasingly difficult and entails growing and unnecessary hardships.

The ingenuity of men should be pointed toward finding the means to maintain employment and, in case of need, to restore it to a sound basis even though the process may at times require the temporary support of government. Success in such efforts would result in preserving the normal mentality of the workers and would enable them to live in happiness and contentment.

Following the War the industries throughout Europe could all have started up together if confidence had been restored through insurance against loss. Such protection could have been extended by their governments on a sound insurance basis, on condition that they would produce on the normal pre-War basis. Since the desires of the people for comfortable living were the same as they had been before the War—and they were actually greater because of the experience—and since the wide reestablishment of industry would have enabled the people to satisfy such desires, there could have been a return of all men to work exactly as happens after a holiday.

NOW IS THE TIME TO SOLVE THE PROBLEM

Following a trying period for mankind, not during it, the lessons taught by the emergency should be studied, and ways should be found to prevent recurrence of the conditions that caused it. With the picture of post-War Europe before us, are we in the United States going to follow blindly in the same path and make the same mistakes? Are we going to accept the unfortunate system that has so increased the intensity of the normal cyclical movement of industry that many nations cannot see their way out of the morass into which it has led them? Time only will tell.

Deep Tunnels for Delivery of Water Supply

Large Cities Can Often Be Best Served by Trunk Mains Driven in Rock

By WALTER E. SPEAR

MEMBER AMERICAN SOCIETY OF CIVIL ENGINEERS
DEPARTMENT ENGINEER, BOARD OF WATER SUPPLY, NEW YORK, N.Y.

FOR their growth and even for their existence, cities require a plentiful supply of water. But the most crowded sections of cities, where in general the most water is needed, often have their streets filled with rapid transit lines and with public utility conduits and structures of all sorts, both above and below the surface. Therefore the construction of large water mains in these sections is not only difficult but also unduly expensive. Drawing chiefly from his experience in New York, Mr. Spear concludes that where solid rock is near enough to the surface, deep pressure tunnels driven through it will provide the safest and cheapest method of supplying water to congested districts, or of conducting water through them to outlying areas. His paper was originally presented on January 19, 1933, before the Sanitary Engineering Division at the Annual Meeting of the Society.

AS a modern city increases in size and complexity it may become increasingly difficult to find room in the streets for the large trunk water mains that are necessary to supply the growing community and provide adequate fire protection. This is particularly true in our American cities, with their subways and high buildings and their large per capita use of water.

Large cast-iron or steel conduits cannot very well be laid parallel with and over sewers, or under car tracks. The space in a street of ordinary width in which to place such mains is often limited, and a rearrangement of existing subsurface structures in congested districts is frequently required. If the need of large trunk mains in congested districts could be anticipated and they could all be laid before they were needed and before other pipes and ducts had filled the streets, there would be little difficulty so far as smaller pipes were concerned, but such foresight is rarely possible. As a matter of actual practice, it is not customary to lay distributing conduits much more than ten years in advance of requirements.

In a city like New York, where the ordinary basement is not over 10 ft below the curb level and the street sewer is just a little lower, a 66-in. pipe is about as large as can be comfortably laid without interfering with sewer connections. However, many 72-in. pipes have been laid in New York, although not without relaying some house connections and building some additional sewers. Yet even the smaller sized pipes laid at a depth sufficient to prevent freezing and to clear smaller water mains, gas pipes, and electric, telephone, and other ducts, create a serious obstruction to transverse pipes that must be kept below the frost line, and force any subway or gallery construction to a depth of 10 ft below the street surface. Of course there is the consideration that it may not be entirely safe or altogether advisable to build such a structure as a rapid-transit subway in the same street as a large water pipe.

If, because of political boundaries or physical obstructions such as deep waterways or high hills, it is necessary to supply large parts of the city through the congested streets of a built-up district, ultimately it may be necessary to construct the larger conduits below the level of all existing subsurface structures.

Conduits 10 ft or more in diameter may be built in open cut through the city streets like rapid-transit subways. Such construction may create as much disturbance as the building of a subway, and its cost will necessarily be high. If large steel conduits to carry water under pressure are surrounded by concrete and lined with mortar, they may be considered reasonably permanent, but they present some hazards due to settlement from still deeper street excavations or to movements in adjacent excavations for deep foundations. Open-cut excavation for a conduit is of course impossible if a subway is already in the street.

Tunnels of large diameter may be built in soft ground, under compressed air or otherwise, much deeper than is

CONFLICT IN STREETS BETWEEN WATER CONDUITS AND OTHER SUBSURFACE UTILITIES
Left: Even in Purely Residential Districts a 72-In. Conduit Seriously Interferes with Secondary Mains
Right: A 72-In. Main in a 100-Ft Street Forced Out of the Roadway and Under the Sidewalk by a Rapid Transit Subway

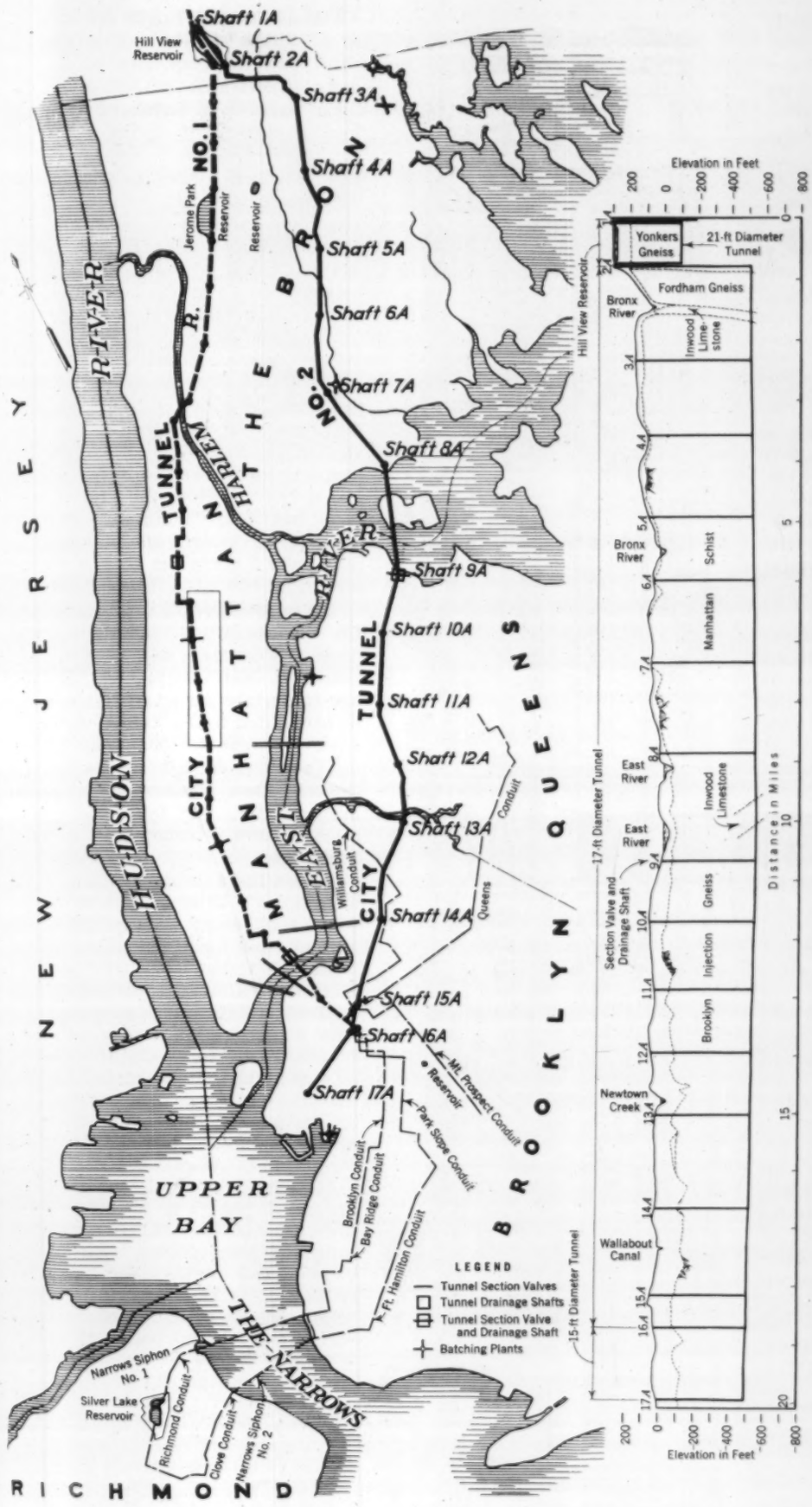


FIG. 1. NEW YORK CITY'S DEEP TUNNELS FORM A 37-MILE CLOSED LOOP
Tunnel No. 1 Was Built in 1916, and Tunnel No. 2, Shown in Profile, Is Under Construction

possible in open cut. The former method was used for the tunnels serving intakes or suction lines for large areas in Detroit, Chicago, Cleveland, Cincinnati, and elsewhere. In many cities such tunnels would have to be constructed under compressed air because of the absence of rock near the surface. If they are provided with steel interlinings they will serve to deliver water under pressure, and if they are constructed in tunnel, from shafts placed from half a mile to a mile or more apart and outside the street limits, traffic need not be appreciably affected. But some settlement would be unavoidable and this might affect street pipes and ducts and do damage to buildings if they were not well underpinned.

While such deep tunnels in soft ground are less subject to damage than large conduits laid in open cut just below the surface, they cannot be considered altogether safe from seismic disturbances. Their greatest usefulness appears to be in carrying water under little or no pressure. They are naturally subject to surface pollution if the groundwater level is above the hydraulic gradient. Such tunnels have the advantage common to any form of large conduit built below all subways, pipes, and ducts, in that they can be constructed into the heart of any large district to provide ample volumes of water where most needed.

When conditions permit, the ideal solution for this problem is found in deep pressure tunnels in rock, lined with masonry, such as have been constructed extensively in New York to deliver the Croton and Catskill supplies. Such tunnels are used to a smaller extent in Philadelphia and Cincinnati. They are only feasible where the rock lies near the surface or at such limited depths below the water table that the shafts for the necessary outlets and connections to the street mains can be sunk within reasonable limits of air compression and at economic intervals. It must therefore be admitted that such tunnels have a somewhat limited field of application.

The advantages of delivery tunnels in sound rock are many. They may be driven several hundred feet below the surface, where they will create no disturbance whatever in the streets, since the shafts can be placed outside the street limits. No settlement can occur above tunnels of reasonable depth in sound rock. Also they provide safety from surface construction; they are less vulnerable to borings than tunnels in earth; and they are reasonably safe from seismic disturbances and from any serious malicious injury from high explosives. Experience indicates that even a movement in the rock transverse to the axis of the tunnel would only rupture the lining where the movement occurred. The parts of such construction most vulnerable to earth movement are the shafts. If these are well anchored in sound rock and surrounded above the rock by reasonably firm earth, the amplitude of vibration in them would probably be small, and the damage would be limited to the surface construction. Even if all pipe connections were broken, the shafts would provide locally a supply of water to fight a conflagration if control of the water were provided below the rock surface, as is done in the New York tunnels.

Even if it were possible to lay a sufficient number of cast-iron pipes or steel conduits in the streets, a large pressure tunnel of equivalent capacity in rock would be cheaper in first cost, although a tunnel is not adapted to piecemeal construction as are the greater number of conduits. For example, it was estimated when City Tunnel No. 1 of the Catskill Aqueduct was proposed in New York, that thirty 48-in. cast-iron pipe lines, or sixteen 66-in. steel conduits would be necessary to provide the same carrying capacity as a 15-ft pressure tunnel, and that the cost would be fully twice that of a tunnel. Furthermore, such a tunnel may be considered a permanent structure; the pipes are not. An equivalent tunnel in earth with a steel interlining of sufficient thickness to carry the pressure, if driven under compressed air below the water table, would be more expensive than a tunnel in rock but in general somewhat more economical than cast-iron or steel pipes of equivalent capacity in the streets. Deep waterways within a city, requiring submarine pipe lines, would make delivery tunnels by far the more economical construction as compared with an equivalent number of pipes. If there are high hills within a large distribution system, such construction may prove to be unavoidable.

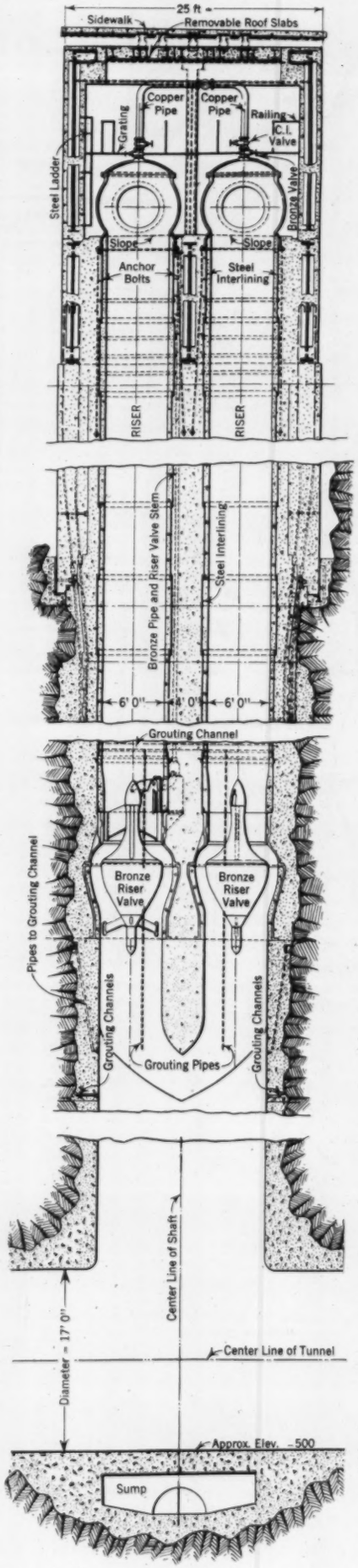


FIG. 2. SECTION THROUGH A SHAFT IN TUNNEL NO. 2

Double 72-In. Riser Pipes, Shaft Cap, and Riser Valve. The Riser Valve Is Controlled by a Hydraulic Cylinder Contained Within It and Its Speed Is Reduced Toward the End of the Stroke to Prevent Water Hammer

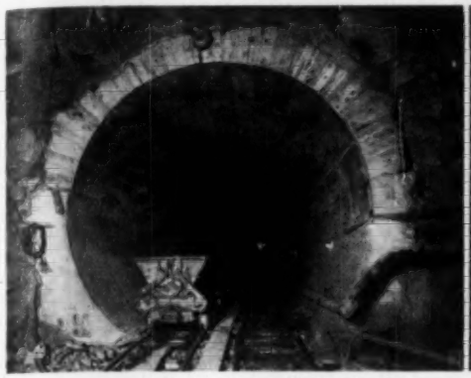
Tunnels in earth can be driven only at moderate depths below ground water and must be located largely under streets and parks to avoid the initial expense of rights of way and possible settlement during construction, with resulting damage to buildings. A deep tunnel in rock, on the other hand, may be constructed anywhere without regard to street and property lines. City Tunnel No. 1 of the Catskill Aqueduct, constructed between 1911 and 1916, was located almost entirely under streets and other public lands, but New York's second delivery tunnel, known as City Tunnel No. 2, now approaching completion, has been driven to a larger extent under private property. The cost of rights of way across private property for this last tunnel, generally 500 to 600 ft below the ground surface, has been nominal. On the average, the awards amounted to but little over 2 cents per foot of tunnel for a right of way 25 ft in width.

There are no noticeable shocks at the surface from blasting in such deep rock tunnels, and in New York there has been no evidence of damage to surface structures that could be attributed to the tunnel construction. Air concussions reaching the surface through the shafts have broken some window glass in the immediate vicinity but have caused no structural damage to adjacent buildings.

Where there is any choice in the location of a tunnel, fault zones and weak rock must be avoided. Particular care must be taken not to locate the tunnel along the line of a fault or within the disturbed zone adjacent to it. If possible, a fault zone and a band of weak rock should be crossed at right angles. Indeed, in any highly tilted sedimentary formation, less trouble in driving and supporting the rock is experienced if a location parallel to the strike of the formation is avoided.

It is rarely possible to select the ground in which a tunnel is to be driven. Massive rocks without bedding and joint planes, such as were encountered in the diversion tunnels of the Hoover Dam, are ideal and rare. Hard igneous or highly metamorphic rocks that have been subject to

movement and are even slightly fractured, but not much decayed, are likely to carry considerable water, as are some limestones with or without solution channels. Sedimentary and metamorphic rocks that have yielded to movement without fracture, or in which the products of decay fill the seams and make them tight, are excellent rocks for tunneling although they may offer difficulties of support during driving. In any rock formation, it is to be expected that the difficulties of driving and supporting the tunnel will increase with the diameter.



Showing Thickness of Lining in 17-Ft Pressure Tunnel

72-In. Bronze Shaft Caps and Valves Control Outlets to Distribution System

NEW YORK CITY'S TUNNEL NO. 2 UNDER CONSTRUCTION

AMOUNT OF ROCK COVER CONSIDERED

Theoretically it would be safe to construct a pressure tunnel in sound rock with a minimum cover of 50 ft over the arch of the tunnel, provided the additional overburden of broken or decayed rock and earth provided a weight in the total volume of the prism above the tunnel sufficient to overcome the maximum hydrostatic pressure in the tunnel. Such a meager cover is not, however, considered good practice, even in a district where slight leakage would do no harm, because it is impracticable to make enough borings in any critical area to determine the lowest elevation of sound rock over the tunnel and in its immediate vicinity. However thoroughly the preliminary explorations are carried out and the subsequent grouting done, there may be unfilled seams and joints that will later carry water under pressure from the tunnel to the surrounding ground, which may cause some movement and result in serious leakage.

A sound rock cover of not less than 150 ft appears to be a safer basis of design, and unless the rock is unusually sound, a greater coverage is desirable, depending, of course, on the magnitude of the unbalanced pressure to be carried in the tunnel. With increasing depth, the difficulties arising from leakage through small seams and joints in sound rock appear on the whole to decrease, and the decay along such seams resulting from natural water circulation largely disappears. Although conditions improve with depth, experience indicates that major fault lines, as evidenced by open fissures and wide zones of crushed and decayed rock, cannot always be avoided by locating the tunnel at any reasonable depth below the surface. Such fault zones must be crossed on the shortest possible line, and the tunnel must be carefully excavated and supported. Perhaps steel reinforcement in the concrete lining will be required and also a steel interlining sufficiently heavy to carry the full water pressure.

A masonry lining, now universally made of portland cement concrete, is necessary in a rock tunnel to provide permanent support for the rock and to give a smooth waterway. Such a tunnel well below the water table is necessarily circular in section so that the lining can withstand the exterior ground-water pressure when the tunnel is empty and can sustain the still higher pressures of the grouting that is done to fill the seams and thereby consolidate and make tight the surrounding rock.

In calculating the required thickness of the lining by means of the Lamé or other formula for thick hollow cylinders, it should be assumed that the lining is exposed for its entire periphery to the full hydrostatic head of the exterior ground water. Probably this condition is rarely if ever realized, yet the thickness thus obtained, when used with some judgment, has given satisfactory results. At least one failure in a pressure tunnel lining has resulted from making the thickness of the lining considerably less than that so computed. In New York's delivery tunnels, from 11 to 17 ft in diameter, the thickness of the linings, within which no large areas of rock have been allowed to encroach, range from 15 to 19 in. under exterior ground-water heads of from 200 to 700 ft.

TUNNEL LEAKAGE SMALL

The concrete lining of a pressure tunnel may not be depended on effectively to stop much outward leakage because the application of water pressure when the tunnel is filled and in service compresses the solid rock behind the lining within its elastic limit and also closes up the slight cracks that have been caused by the heavy shocks of blasting. This yielding naturally opens the longitudinal joints in the lining and causes slight cracks in the concrete. Furthermore, some transverse cracks due to the shrinkage of the concrete are always in evidence, and slight inward leakage from many of these cracks when tunnels have been unwatered indicates that water may escape through them.

After the voids about the concrete lining have been filled with thick grout, a thorough application of thin grout under high pressures is necessary to fill, as far as possible, all cracks and seams in the rock. This is one of the most important features of pressure tunnel construction if satisfactory tightness is to be secured. Even the slight outward leakage that is inevitable in any pressure tunnel diminishes with time as silt gradually fills the fine cracks.

DEEP TUNNELS IN ROCK RECOMMENDED

In conclusion, the general statement may be made that deep delivery tunnels are required only by our larger cities, where great volumes of water must be delivered through congested districts, the streets of which are already occupied by, or must be reserved for, rapid-transit subways, sewers, pipes, and ducts. Pressure tunnels in rock are cheaper than pipe lines of equivalent capacity laid in the streets and are less liable to damage and interruption from other construction or from earthquakes than pipes or earth tunnels. Pressure tunnels in rock may be considered permanent structures.

Codes for Foundation Practice

Recommendations for Contractual Relationships Between Owner, Engineer, and Contractor in the Construction of Foundations for Bridges and Buildings

UNDER the chairmanship of A. J. Hammond, President Am. Soc. C.E., the Construction Division's Committee on Substructure Engineering is carrying forward several valuable studies. At the Annual Meeting of the Society, two of its subcommittees presented progress reports before the session of the Construction Division on January 19, 1933. These subcommittees have been studying codes of practice to establish equitable relationships between owner, engineer, and contractor, one for building foundations, and the other for bridge foundations. The codes aim to correct certain undesirable practices and to eliminate, as far as possible, elements of doubt and hazard that have formerly existed in many foundation projects. For instance, it is recommended that complete information as to subsoil and other conditions should be made available to both engineer and contractor prior to the design of the work so that risks will be avoided, or at least known before actual construction is undertaken. The subcommittee progress reports, here abstracted for the immediate information of readers, outline the measure of responsibility that should be assumed by owner, engineer, and contractor.

The Subcommittee on Buildings consists of L. R. Viterbo, Chairman; Charles R. Gow, H. H. Hadsall, Frederick H. McDonald, L. E. Ritter, and J. Wright Taussig, all Members Am. Soc. C.E. The Subcommittee on Bridges is composed of Carlton S. Proctor, M. Am. Soc. C.E., Chairman; A. C. Everham, M. Am. Soc. C.E.; and A. J. Hammond, President, Am. Soc. C.E. The illustrations used in this symposium have been furnished through the courtesy of Moran and Proctor, Consulting Engineers.

Contractual Procedure for Foundations of Buildings

By L. R. VITERBO

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CHAIRMAN, SUBCOMMITTEE ON BUILDINGS, COMMITTEE ON SUBSTRUCTURES OF THE CONSTRUCTION DIVISION OF THE SOCIETY

CONDITIONS affecting the foundations of a structure are usually the only ones that cannot be definitely determined in advance of construction. The owner selects the site, subject in some cases to the judgment of the engineer, and the engineer, as the owner's agent, designs the foundation. As the contractor is not usually consulted regarding the design, he should not be held responsible if underground conditions are different from those indicated on the plans and in the specifications.

There should be two contractual steps in every structural problem, one prior to the design, and the other for the design itself. The first, or site-exploration contract, must be undertaken before the design is started or even assumed, since its purpose is to minimize the uncertainties pertaining to subsoil conditions. Prior to the preparation of plans, this first contract should be let to an engineer thoroughly familiar with foundations and the mechanics of soil, for the investigation of subsoil or other conditions that may affect the structure.

Only one pre-design contract should be let, and it should include a complete survey of the area, to consist of the following: borings; test pits; soil tests; location of all underground sewers, old wells, public utilities, adjacent buildings and tunnels; and a complete report on all subsoil conditions. Sufficient fees should be allowed for a complete and accurate study of the conditions involved. Failure to secure such data may result in danger to the finished structure, serious financial loss to the owner, and possible loss to the contractor.

While two separate contracts with the owner are desirable, one for the pre-design investigation and the other for the design, both may be embodied in one document, providing the engineer selected is qualified to undertake both contracts. However, the need for separating the two types of work is most important.

The subsoil investigations should include sufficient core borings to indicate the character of the material to be penetrated; to assure the presence of the anticipated bearing material to a depth of 15 or 20 ft below the elevation of the base of foundations; to give data required for the preparation of contours of the material on which the foundations will rest; and to demonstrate whether there are unsatisfactory underlying strata.

All available information should be obtained concerning the conditions encountered in excavations or soil investigations on or adjacent to the site, with particular reference to the methods employed, the character of materials encountered, and the water conditions found.

Only competent and experienced drilling companies of known integrity should be employed, and the engineer's representative should be present during all boring operations to supervise the taking of samples and check the changes in stratification. Core borings in rock should be of sufficient depth to determine the extent of soft and hard rock, and to obtain from bedrock a solid core of such length as will assure the minimum thickness required for design purposes.

Samples of the various stratifications in each boring should be carefully preserved and kept available for the information of the bidders. Cores of rock should be kept in boxes and marked as to depth and location.

Samples of other materials, in their natural condition, should be placed in sealed glass containers immediately after being removed from the ground and should be marked according to the boring and elevation from which they are taken. At times it is desirable to dig open pits or test caissons to determine the flow of water and the exact nature of the soil in its original condition. If this is done, careful record of the elevation and amount of water encountered should be kept by the engineer, together with samples of materials penetrated. Where possible, skeleton sheeting should be used in the pits, so that changes in strata may be observed.

The boring and test data should become a part of the contract, their correctness being guaranteed by the owner, but the contractor should take the responsibility for soil conditions between borings. The distance between borings or tests should not be greater than 50 ft from center to center unless the owner is willing to guarantee not only the correctness, but the sufficiency, of the borings. When spread or floating foundations are contemplated, one or two soil loading tests should be made on the site. The results of these tests, however, should only be considered as a guide in determining the safe bearing capacity of the soil.

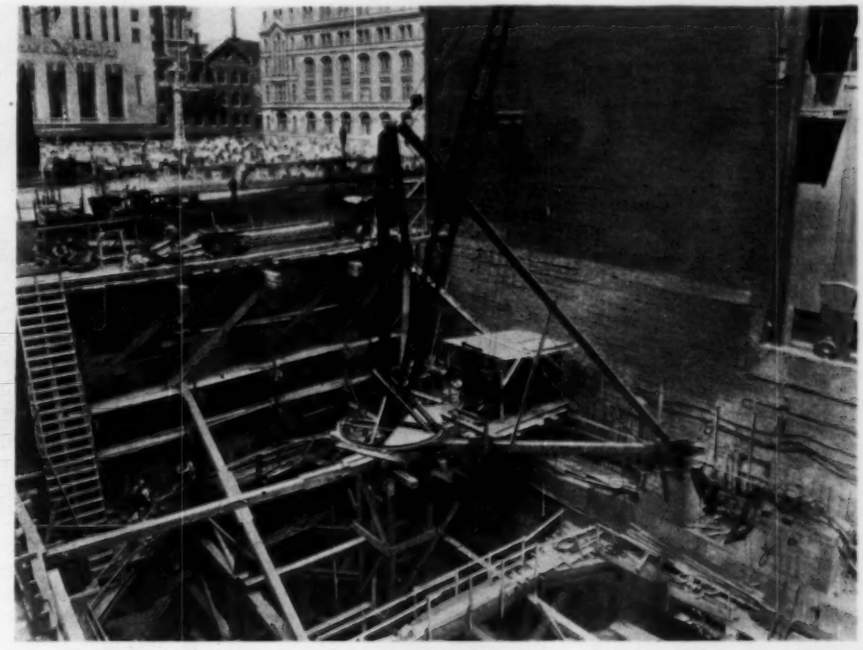
The subsoil investigation should include an encumbrance report showing all available information on the site and the land adjacent to it that can reasonably be expected to affect the cost of the work or the risk in its installation. This report, to be made part of the plans and specifications, should include: (1) plans of all construction on the site not to be removed by others, such as water lines and sewers; (2) plans of construction both on adjacent property and in the streets; and (3) such available geologic and historic information as that regarding water courses, filled areas, and old docks and bulkheads. The owner should be responsible for the completeness of the encumbrance report, but if the engineer has submitted all available plans and information and checked them against visible construction, the owner shall not be responsible for variations between the actual construction and that shown on the report.

It is desirable in many cases that the contract for the substructure should be let in advance of, and separately from, that for the superstructure. Substructure contracts for buildings should usually include: general excavation; sheet piling and bracing; underpinning and shoring, if required; column and wall foundations; and concrete walls up to grade.

Wherever the classification of materials affects the cost of the work, such classification should be made. This would include earth, hardpan, boulders, and rock. Where quicksand is encountered, it should be noted to warn the constructor as well as protect the owner. The engineer should define soft and hard rock, and should also state the size of boulders encountered.

Material that can practicably be removed and handled by pick and shovel or other hand methods, or loosened and removed with a power shovel, is to be classed as earth. A mixture of earth, sand, gravel, and rock or boulders, or rock alone, which can be removed by the use of air-operated hammers but cannot be economically hand picked or removed with a power shovel, is to be classified as hardpan or soft rock. Material requiring drilling and blasting for its economical removal is to be classified as hard rock.

Whenever a construction involves an excavation that by reason of its depth or proximity to adjacent buildings requires unusual sheeting and bracing, such sheeting and bracing shall be designed by an experienced foundation engineer and be shown on the plans submitted to the contractor for bids.



FOUNDATION OF FIRST NATIONAL BANK BUILDING, WALL STREET, NEW YORK, N.Y.
Open-Trench Excavation to Rock 82 Ft Below Curb. Steel Sheet Piles Sealed on Hardpan, 65 Ft Below Curb. Small Plot and Cramped Quarters. Building Occupied in April 1933. Trinity Churchyard in Background

In letting contracts where a large amount of pumping is anticipated, all flows in excess of some predetermined amount should be paid for on a unit basis per cubic foot per foot of lift. On other contracts, the specifications should provide the maximum type and quantity of equipment anticipated, with suitable provision for additional payment if more pumping than expected is required for the completion of the work specified.

In general, equipment rental shall be allowed in accordance with the recommendations of the Associated General Contractor's Manual.

Determination of the time to be allowed for the completion of the substructure requires very careful consideration. Only those with much practical experience are capable of estimating the economical time for performing the work, or arranging penalties on an equitable basis. When these elements have been decided, bonuses equal to the penalties should be provided.

The different types of property damage and liability insurance required by the owner should be clearly stated in the specifications, and should be limited to those commercially obtainable. It is usual to have the foundation contractor "save the owner harmless" from the claims of the owners of adjoining properties. Unjust claims of adjoining property owners often cause the withholding of large sums of money from the contractor's payments. The contract should contain a provision to allow the contractor to bond such claims.

The plans for the contractor shall include a plot plan with full dimensions referred to permanent marks. On it grades shall be referred to a definitely designated datum and to at least one properly designated bench mark on the site. Also, it shall show the distances from the lot line to adjacent constructions, properties, and streets, if any. The relation between the information contained in the encumbrance report, previously referred to, and the new construction proposed, shall be shown, together with the complete plans for the proposed foundations, with elevations and locations referred to the plot plan.

The specifications need include no reference to the design and, in general, should avoid limiting the contractor as to methods, referring only to the desired results. In this way the owner will be able to secure the benefit of prices on competitive methods from the contractors. As nearly as practicable the specifications should follow the standard specifications on materials issued by appropriate authorities, and the design limitations should conform with standard practice, modified as may be required by local building laws.

PITTSBURGH FEDERAL BUILDING UNDER CONSTRUCTION
Basement and Retaining Walls Along Pennsylvania Railroad Tracks; Temporary Steel Bracing Over Sub-Basement Area in Foreground

It is highly desirable from the point of view of both owner and contractor to minimize unanticipated extra work. This can be effected to a large extent by careful and adequate investigations prior to the letting of the contract. The detailed procedure for extra work should be clearly specified. General clauses placing the entire responsibility for such costs on the contractor are unfair and improper, and unnecessarily increase the original price to the owner, since the contractor may be expected to evaluate these risks and include them in his original bids, so that the owner pays for them whether they occur or not. The specifications should provide that if conditions are found requiring extra or unanticipated work, not covered in the plans and specifications, the contractor shall notify the owner that such conditions exist and the additional work shall be executed by the contractor on the basis of (1) the cost plus a stipulated fee, or (2) a lump sum or unit prices to be agreed on before the extra work is undertaken. If the contractor and owner cannot agree on one of these bases, the contractor may proceed with the extra work if in his opinion the delay occasioned by its non-performance will increase the cost of his contract work. The question as to the propriety and cost of the additional work shall then be settled by arbitration. All contracts should include a standard arbitration clause covering all disputes that may arise between the parties to the contract.

The proper tolerances expected in the construction of the work shall be specified in the contract, as this avoids argument during construction. In general, this procedure not only assures more satisfactory construction for the owner but also eliminates uncertainty and risk to the contractor from unreasonable or unexpected requirements.

For caisson construction, the center of any caisson, measured at any horizontal plane, shall be allowed a tolerance from the design of 1/60 of the depth to such plane, but such center shall not deviate from the actual axis of the caisson more than 5 per cent of its actual diameter at such plane. The area of any caisson, measured at any horizontal plane, shall be allowed a tolerance of 5 per cent of its designed area at that plane. The top of any caisson shall not be above the elevation specified nor more than $^1/_2$ in. below that elevation. In case it is not practical to control the inflow of water in any caisson so as to permit the placing of concrete without separation of its constituent materials, concrete may be placed in the caisson through still water by means of a tremie or bottom-dump bucket.

Not only should the material on which the caissons shall rest be specified in general terms—as rock, hardpan, or gravel—but also the specifications should contain provisions covering the minimum load bearing capacity of the materials under actual test in order to eliminate the personal equation in determining the suitability of the material to sustain the contemplated loads. In general, this can be done by specifying that compression tests on rock shall show a crushing strength under laboratory conditions of at least eight times the proposed unit bearing, and that load tests on yielding materials, such as clay, gravel, or hardpan, shall sustain twice the contemplated unit loading with a maximum allowable settlement of $^1/_2$ in.

For caisson work, prices should be obtained on the complete foundation from the column bases to the predetermined depth of the caisson at which the proper bearing material is anticipated, and should be either stipulated by the engineers or submitted by the contractors for a greater or lesser depth than that predetermined. Prices for additions and deductions should be computed on the basis of volume.

On all pile foundation work, regardless of the type of pile to be used, the specifications should provide that the piles as driven shall not deviate from the vertical more than $^1/_8$ in. per ft of length and shall not vary more than 3 in. from the location shown on the plans, or that proper additional construction shall be provided. The condition of the excavation when the piles are to be driven should be described in the specifications. The soil movement and ground swell should be considered in determining lines and grades for excavation. Spacing of all piling should be determined by the shape and size of the piles and the character of the soil into which they are to be driven. In most cases the piles should not be spaced closer than 2 ft 6 in. from center to center.

The design loading should be determined by soil analysis, by preliminary load tests (where the magnitude of the work or uncertainty of the conditions requires), and by local experience, and should not exceed that provided in the applicable building code, nor that hereafter suggested for particular kinds of piling. The method of determining by driving when a

pile shall be considered capable of supporting the designed load should be stated, preferably by means of pile driving formula. Load tests should be provided for, and several individual piles should be loaded with a dead load of from $1^1/_2$ to 2 times the designed load, with an allowable settlement of $^1/_{100}$ in. for each ton of load.

Jetting may be permitted and sometimes may be required. After the jetting is stopped, jetted piles should be struck by a hammer the number of blows required, as determined by test piles, to bring them to the bearing capacity required to support the loads specified. The type and size of the driving equipment should be such that the required efficiency and workmanship will be obtained.

For pile foundation work, it is recommended that quotations should be obtained covering the number of piles shown on the plans according to an estimated base length, to be determined from the reports of the subsoil investigation. The contract should include unit prices per pile for piles added or deducted from the number shown in the plans, and unit prices per foot for piles longer or shorter than the assumed base length.

TYPES OF PILES TO BE DESIGNATED

For timber piles the minimum diameters at top and bottom should be specified as well as the limitations as to straightness. The specifications should also name the allowable kinds of wood and state whether or not the piles are to be peeled. If wood piles are to be lagged or spliced, the specifications should designate the type of workmanship, with details. The cut-off for wood piles should be designated as below permanent water level. The design load on a wood pile should not exceed 25 tons per pile.

When cast-in-place concrete piles are used, their shape and size should be specified as well as the strength of the concrete with which they are to be made. The specifications should state whether or not a permanent steel shell is to be left in place, and should describe such methods of installation as will be satisfactory to the engineer. Inspection should be required before any pile of this type is filled. The design load on cast-in-place concrete piles should not exceed 35 tons per pile.

Where composite piles consisting of wooden sections and cast-in-place concrete sections are used, the general requirements for the wooden sections should be as previously outlined for wooden piles and those for the concrete sections should be as given for cast-in-place concrete piles. The joints of composite piles should be required to be below permanent water level, and the specifications should give the requirements for the details of the joint. The design load on composite piles should not exceed 30 tons per pile.

For precast concrete piles, the specifications should state the required shape and size of the piles and the strength of the concrete of which they are to be made. The specifications should describe the methods of workmanship, with special reference to forms and curing methods. The reinforcement should be designed to provide the necessary strength to resist the stresses developed during handling and driving. The design load on pre-moulded concrete piles should not exceed 40 tons per pile.

GAS HOLDER FOUNDATION, WASHINGTON (D.C.) GAS LIGHT CO. Spread Footing Under Circular Wall; Water Seal Between Central Earth Core and Wall. Capacity of Tank, 4,710,000 Cu Ft

Where steel-pipe piles are used, the dimensions of the pipe and the strength of the concrete should be specified. The allowable methods of joining the sections of pipe together should be stated, and the allowable ratio of length to diameter given. The piles may be driven with the end closed, using steel shoes, in which case they should be considered as concrete piles moulded in place, or they may be driven with the end open and cleaned out afterward. Allowable loads will be determined by consideration of the following factors: the unit stress on the steel of the pipe, the unit stress on the concrete, the method of driving (whether with closed or open end), the material on which the piles rest, the soil analysis, and actual load tests where practical.

Code of Standard Practice for Bridge Substructures

By CARLTON S. PROCTOR

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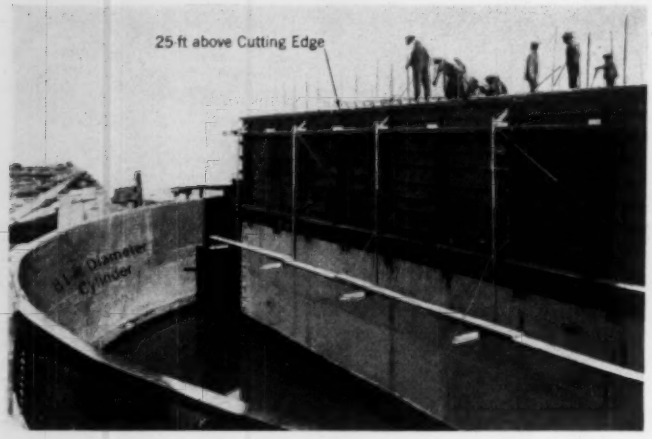
TO provide a basis for a better understanding between the owner and his engineer, and between these two and the contractor who performs the work on a bridge foundation, it is first desirable to allocate the responsibility that should properly be assumed by each of these three parties.

For the design and supervision of bridge foundations, it is the owner's responsibility and duty to employ an engineer thoroughly trained in design and experienced in construction methods. The owner should provide the necessary funds for a complete preliminary investigation of soil, geological formation, water conditions, and other data for the determination of all facts that should be known to enable the engineer to properly design the

work and the contractor to accurately determine its cost. The owner's contract with his engineer should require that the engineer supervise such preliminary investigations and prepare a complete design based on methods of installation determined as a result of the engineer's investigations, experience, and knowledge. When the contract is drawn, the owner should accept his share of the responsibility for unknown factors affecting the installation.

The owner should acquire or have option on the right of way in advance of the letting of the contract and be



SINKING A PIER CAISSON IN A "SAND ISLAND"
Suisun Bay Bridge, Southern Pacific Railroad, California: 81-Ft Cylinder Filled with Sand to Form the Island

able to satisfy the bidders that funds will be available to make all payments in accordance with the terms of the contract. Should the owner be unable to make payments to the contractor as provided under the contract and the contractor be obliged to stop or abandon the work under the contract, then such stopping or abandonment on the part of the contractor shall not make him liable for any subsequent damage to the unfinished work.

After the award of the contract, should the contractor be delayed in the prosecution of the work by any act of the owner or his agents, other than as provided in the contract, and should such delay result in extra cost to the contractor, then he shall be reimbursed for such extra cost as determined by the engineer and provided in the contract.

ENGINEER'S RESPONSIBILITY

The engineer should make every effort to assure the accuracy and completness of the preliminary data in so far as these data control the type of design, method of installation, or stability of the foundation. He should include with his design, for the contractors' information, complete records of subsoil and other preliminary investigations. His design should include not only details of the foundation, but also the major temporary elements of construction necessary to installation, based on a careful predetermination of the methods best suited and most economical for the conditions to be met. His specifications should give the contractor the option of submitting to the engineer details of temporary structures and methods of construction as an alternate to those called for by the engineer, which may be adopted subject to the engineer's approval. Such approval by the engineer should not relieve the contractor of his responsibility to carry the work to a successful conclusion in a manner acceptable to the engineer. His specifications and contract should be drawn so that he will be empowered to control the work at all times by his supervision and to accept or reject elements of the work as installed.

The engineer should draft contract documents in a spirit of fairness and equity, and during the prosecution of the work he must function in a fair and impartial way as arbiter of all questions at issue affecting the contract or relations between the contracting parties. The engineer's decisions in all matters affecting the contract should be final, except that the specifications should provide for arbitration of disputes and define the arbitration procedure. The specifications should define "arbitration" as precedent to any action at law.

CONTRACTOR'S RESPONSIBILITY

It is the contractor's duty to bid only on work for which adequate preliminary information has been developed, and for which adequate designs and specifications are prepared by the engineer. He should not bid on the work until he has satisfied himself as to the adequacy of the information given and the practicability of the type of installation shown on the engineer's design, and after having obtained the proper information, which should be issued to all bidders alike. Should he be awarded the contract, he should recognize and accept his full responsibility for the successful and safe prosecution and completion of the work in accordance with the contract documents. For the consideration of the engineer, the contractor may submit plans and details showing his own methods of installation, erection, plant layout, and temporary structures, but before such methods are adopted, the contractor must receive the engineer's approval.

Variations in subsoil conditions as uncovered during the progress of the work shall not relieve the contractor of his responsibility, or entitle him to extra compensation unless such conditions are obviously at variance with the preliminary information supplied, and the error in such preliminary information is firmly established. Minor variations discovered in the subsoil or other conditions that do not actually result in additional cost to the contractor should not be the basis for any claim against the owner for extra compensation.

If at the time of signing the contract the contractor recognizes the existence of hazards, the responsibility for which he is unwilling to accept, his exceptions should be properly noted in the contract. No contractor lacking experience, or unable to properly finance, equip, or direct such work should enter into contract to perform it.

COMPLETE PRELIMINARY SOIL INVESTIGATIONS

Without adequate preliminary investigation of soil conditions, and in extensive work this would include a geological report, so many risks must be taken by the contractor that his bid would reflect the cost of the risk to the disadvantage of the owner.

The owner should employ, at his engineer's selection, a competent contractor or agent to procure samples of subsoil materials as directed by the engineer. This work should be carefully developed and supervised by the engineer and, where required, samples of the materials should be subjected by the engineer to thorough laboratory analyses, for determination of data as to scour, skin-friction resistance, slides, mud waves, supporting value of subsoil materials, earthquake impulses, and other pertinent data. The engineer should have a knowledge of soil mechanics and laboratory practice and methods, and should be specifically experienced in methods of design and construction of bridge foundations.

The engineer should decide as to the type, number,

and extent of borings, and describe acceptable methods for wash and core drilling in rock and soil, and the requirements for taking and preserving the samples. In general, wash borings should not be used except between desired sample levels, and the method of procuring samples should be such as to provide material in its natural and undisturbed condition. Borings should be taken to bedrock or, where bedrock is not accessible, to such depths as will give the necessary information as to substrata below the probable depth to which foundations will be carried. In compressible soils, borings must go to such depths as may be necessary to permit determination of the future compression of the underlying soil.

On important work, borings into rock should be carried at least 20 ft into solid ledge rock, and at least one boring at each pier should be carried a minimum of 50 ft into rock to determine whether mud seams, fissures, or faults are present. Only competent and experienced drilling companies should be employed, and the engineer's representative should be present in a supervisory and inspecting capacity at all times during the taking of samples. Marked samples should be preserved for the information of bidders.

Data on borings should be tabulated and indicated on drawings, as a part of the contract documents, and the owner should guarantee the accuracy of the borings at the locations taken within reasonable tolerances as to elevation, change of stratification, and character of soil. It is recommended that the engineer's report as to the character of the soils sampled and analyzed be limited to physical and chemical laboratory analyses, rather than to the usual descriptive terms, which may be subject to variation of interpretation. The samples of soil underlying the base of the foundation should be carefully investigated to determine the approximate rate, and anticipated total amount, of settlement under the assumed bridge loads, and in any earthquake regions, under earthquake impulses.

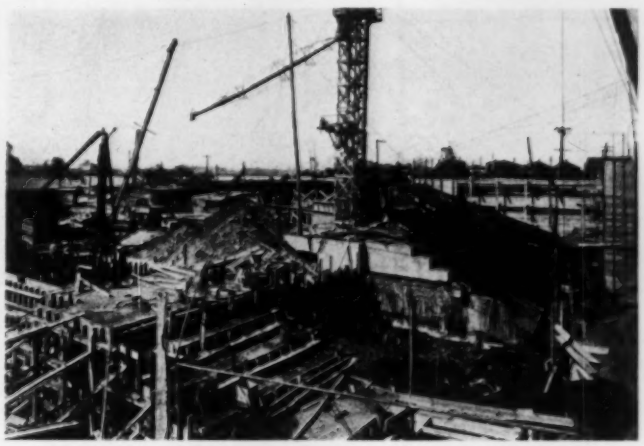
When soil load tests are considered necessary or desirable by the engineer, he should describe in detail the methods for making the tests and for determining and checking the load settlements. He should provide the contractor with drawings illustrating the testing apparatus desired. Soil loading tests should be made whenever possible on the strata that are to be actually loaded by the proposed foundation, and the engineer may prescribe loads of varying intensities on varying areas, depending on the soil characteristics. Whenever the total settlement or rate of settlement under the given load conditions cannot be determined by soil bearing tests alone, such tests shall be supplemented by such other soil analyses and tests as the engineer may prescribe.

Where pile tests are required, such tests shall be made under the direction of the engineer, and he shall provide complete data as to the methods to be used. Hammer tests applied to pile formulas should be considered only as a general guide and should not be taken as a criterion of the bearing values of the piles. Pile tests should generally be made under varying static intensities of load on piles singly and in groups. Frequently soil bearing tests should be made in conjunction with pile tests, since it should be recognized that in large groups of piles the supporting power may be a direct function of the supporting power of the soil materials, and not a function of the capacity of the individual pile.

Open-pit explorations to determine the exact nature of soil in its original condition and the flow of water are desirable for land work or where the depth to water is small. Complete records of all subsoil investigations should be made available to all bidders, including records of soil borings, soil tests, load tests, pile tests, open-pit explorations, and any peculiarities encountered in any of these investigations.

GEOLOGICAL REPORT, WATER CONDITIONS, AND SITE SURVEY

For all large or important bridge foundations, a complete geological report of the site should be made by an expert geologist at the expense of the owner. Such a report should include the history of the geological formation and full general geological information, together with a statement of the probable seismic disturbances, and a map showing active and inactive faults. Where large areas are to be explored, general information, such as depth to rock, can frequently be obtained by the electrical resistance method.



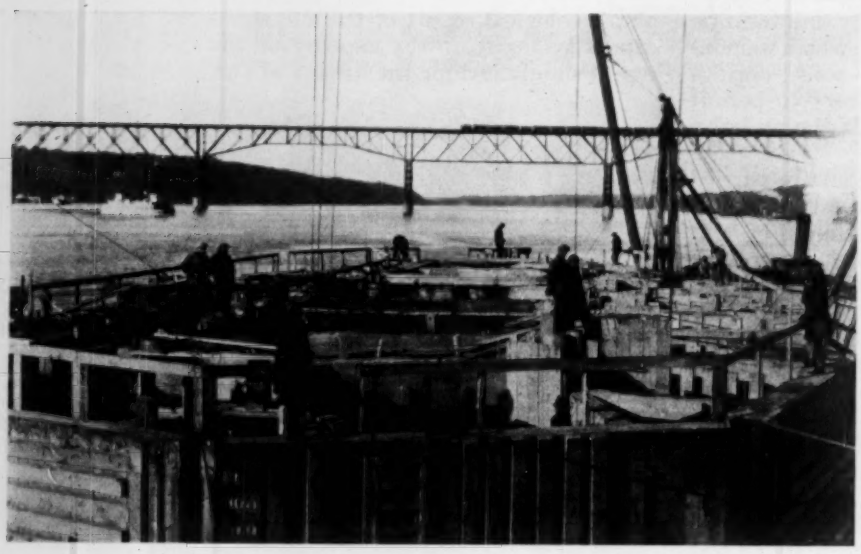
CANADIAN ANCHORAGE, AMBASSADOR BRIDGE, DETROIT
Cross Block Under Construction and Eye-Bars and Grillage for East Cable in Place

Preliminary investigations should include determination of ground-water levels, with seasonal variations, chemical analyses of the water to determine the presence of chemicals or gases, and complete records as to the depth of open water, tidal range, period of high and low water, long-time hydrographs, tidal or river currents, and ice flow. This information should be furnished to the bidders. Investigations should be made as to the extent to which the bottom shifts as a result of variations in current; the extent to which the bottom will probably scour; determinations as to whether mattresses, riprap, or other protection against scour will be required; a statement as to whether the water has been or may be used for driving or booming logs; and careful determinations as to the presence of marine borers. The engineer should obtain data as to channel clearances, lights, signals, fenders, water traffic, and Federal, state, and local regulations, and so draw the contract as to comply with the requirements relating to them.

The engineer should prepare a careful survey indicating the location of the work as planned and should prepare a report for the information of the bidders, such report to indicate, allocate, and describe, as far as possible, all old foundations; docks and bulkheads; water courses; and adjacent buildings, with record as to the type, size, and locations of foundations, and height, type, and weight of superstructure. He should also determine the location and size of adjoining public utilities and prepare a plan showing property or right-of-way limits, pier and bulkhead lines, navigation channels, cables and pipes.

He should state the facts known regarding the hazards to the work due to railroads, street traffic, water traffic, adjacent plants or structures, fire, gases, factory, or other wastes, ice flow, jams, floods, hurricanes, or earthquakes.

The engineer should determine dead, live, wind, impact, centrifugal, and traction loads from the superstructure, together with dead, wind, ice, and water loads on substructures, and the basis of his assumptions as to magnitude of earthquake impulses. Bidders should be given such of these data as they may need for a proper analysis of construction methods and costs.



EAST PIER CAISSON OF THE MID-HUDSON SUSPENSION BRIDGE
At Poughkeepsie, N.Y.

ENGINEER'S DESIGN AND HIS RESPONSIBILITY

The engineer should carefully consider and study all available types and combinations of types of foundations, to determine the design that will best satisfy the requirements for safety, permanence, feasibility of construction, and economy. He should develop his design to show not only the finished construction and methods of installation, but also the details required to demonstrate its feasibility and practicability. The engineer should indicate on his plans and state in his specifications the required protection against such forces as scour, collision, flood, ice, and river hazards, and should require adequate and proper bank stabilization.

Where direct measurements cannot be made, the base lines and center lines of bridge piers should be indicated by the engineer through triangulation, and the triangulation stations and instrument platforms necessary for his use should be provided by the contractor and included in the bid for the work. The engineer should be free to employ an outside surveyor or engineer to check the accuracy of his base lines, bench marks, and center lines.

The engineer should definitely establish in his design and specifications the amount of tolerance in location that will be permissible in the various items of installation, and should include definite provisions for additional installation, reinforcement, and replacement of work, which the contractor must provide if such tolerances are exceeded. For bridge pier installations, the engineer should make frequent determinations as to variation from position and plumb, and he should forewarn the contractor as he approaches the limit on tolerance.

The engineer should provide adequate and competent field supervision of the work and should be at all times ready to accept or reject any part of the work as the installation proceeds. His inspection should include all such items as location work; concrete mixing, placing, and testing; testing and installation of reinforcing and structural steel; quality of timber and its treatment against decay or marine borers; caulking and bracing of cofferdams; caisson anchorage system; and fenders or other protective provisions. Shells in which concrete piles are to be moulded in place should be carefully inspected before the concrete is placed.

EQUIPMENT AND PLANT

The contractor should carefully check the information provided by the engineer as to water conditions and make his own determinations as to pumping requirements. He should utilize the engineer's data as to size and gradient of subsoil materials to enable him to make his determinations as to the feasibility of well-point or other methods. The contractor should be solely responsible for all pumping requirements and water control, and the specifications should be clear as to requirements for continuance of pumping or water control after the completion by the contractor of any element of the work.

Wherever the classification of soils affects the cost of the work to the contractor, such classification should be clearly stated by the engineer, by a contract definition of such terms as hardpan, soft or hard rock, or boulders. The presence of quicksand should be noted.

The engineer's decision as to the point at which the substructure contract stops and the superstructure contract begins should be influenced by consideration of the contractor's plant and equipment so as to conserve the interest of his client and to avoid duplication of construction plant and equipment as far as possible. Rentals for equipment, when not included in a lump sum contract, should, in general, be in accordance with the Associated General Contractor's Manual.

TIME REQUIREMENTS FOR THE WORK

The engineer should give the matter of time requirements for various elements of the work the most careful consideration, recognizing that only those contractors having large experience are capable of estimating the economic time for the performance of the work or of stipulating equitable bonus and penalty provisions. The engineer should recognize that an abnormal decrease in the time allowed for construction must increase the cost, and he should be guided by the method of financing in making his time schedule. Where it is necessary to finance either the foundation operation or the entire bridge project in advance of construction, it is evident that the interest on bonds is of such considerable magnitude that it is to the owner's interest to pay a large bonus for early completion; but where the operation is financed as the work proceeds, the interest on bonds and other carrying charges may not warrant an excessive premium for early completion.

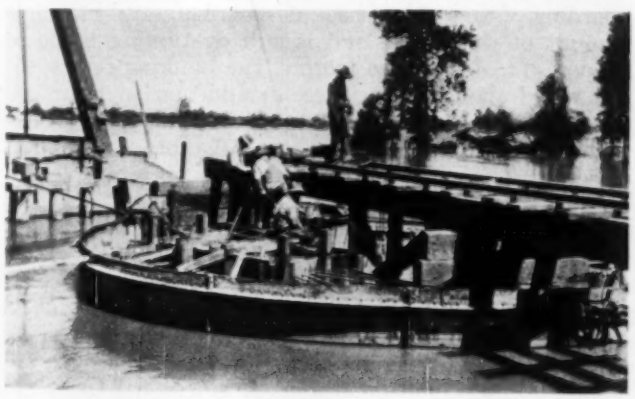
Where a bonus and penalty agreement is required, the amount stated should fairly represent the delay cost of bond interest and other carrying charges. Liquidated damages should be established as the amount of actual damages which the client will suffer by virtue of delaying

any item of the contract. The contract should stipulate the times or limits of time for the commencement and completion of the work and should clearly specify those causes for which the contractor may be granted extensions of time. The amount of time extension allowed should be subject to the engineer's decision, and claims for such extension should be made by the contractor at the time the delay occurs or within a specified time limit thereafter.

The engineer should clearly stipulate requirements as to types, amounts, and limits of compensation, liability, and contingent insurance and bonds, and the extent to which the owner's and engineer's representatives are to be protected by the contractor's insurance. The engineer should also state, for the information of the bidders, the amounts and types of insurance that the owner will carry direct.

In general it is advisable to assist the contractor by paying for the materials required for caisson construction prior to the landing of the caissons, and frequently it is advisable to advance payments to finance the contractor for major plant installations required prior to the start of actual construction. In this case it is usually best for the owner to carry his own insurance to cover installations for which he has made partial payment, but which are floating or still subject to the hazard of plant installation, and to cover payments made for plant equipment in advance of construction. In any case, this question should be made clear in the specifications and the information to bidders, and there should be no doubt as to who carries such insurance.

PHILADELPHIA–CAMDEN BRIDGE, 1923
Caissons for Support of Camden Anchorage Sunk to Rock 103 Ft Below High Water



NEW ATCHAFALAYA RIVER BRIDGE FOR TEXAS AND PACIFIC RAILROAD, MELVILLE, LA., 1927
Open Dredged Pier Caissons, 44 Ft in Diameter, Sunk 164 Ft Below High Water

The engineer should clearly and definitely state the times for all payments and the basis on which they will be made, and what work and materials on hand may be included in the contractor's monthly estimate.

In general the contract should include unit prices for increase or decrease of the various items of work included or contemplated, and should recognize that since the contractor's overhead must be spread over total estimated quantities of the contract, it is fair to expect that the credit for decrease in amount of work will be less than the price paid for increase. Additional work may be done on a cost plus percentage basis, in which case the bid should include the percentages that will be charged for such items as overhead, insurance, and profit.

The owner should permit the contractor to give bond as security against unsatisfied claims in lieu of retaining money on the contract. If the contract has been substantially completed but, owing to the nature of the work, certain operations cannot be performed until a later date, only such amounts should be retained by the owner as will cover the cost of the work remaining to be done. It is unfair to the contractor to withhold a percentage of the total payment on account of such items of work remaining to be done.

Where work of considerable magnitude is to be undertaken and a large amount of plant is required in advance of construction, partial payment is frequently advisable to finance the contractor and reduce the ultimate cost to the owner.

PROFESSIONAL ETHICS AND DUTIES OF THE ENGINEER

The mutual relations and responsibilities of the owner, the engineer, and the contractor shall be evidenced by duly executed written contracts. The engineer should comply with the rules of ethics for his profession. Specifically, while engaged as engineer on a project, he should neither accept as payment for any part of the work done, nor otherwise acquire, any interest or share in, or profits from, the ownership or sale of the securities of the project, the real estate, or any business interest affected by the bridge construction. Nor should he benefit in any way from any interest in the business of the contractor, the use of any patented equipment or processes used on the work, or for service rendered during the conduct of the work to any contractor or subcontractor on the work.

The work to be done by the engineer for the owner, being varied in character and amount, should be defined in considerable detail in the contract between these parties. Such services may include any one or all of the following: preliminary studies, authorization of work, preparation for construction, laboratory work, letting of the contract, conduct of the work, inspection of construction, inspection of materials, field work, control of work and progress, and final settlement of the contract.

Long-Range Planning and the Future of Business

By DAVID FRIDAY
ECONOMIST, WASHINGTON, D.C.

ACCORDING to Mr. Friday, planning will not hasten the recovery of business or restore it to its 1928 status. It will, however, be a factor in moving the peaks in the curves of business fluctuation into the valleys of future depressions. In our technological development not enough study has been given to the effect of new products or new processes on our future economic life. In this field—the investigation of economic change—Mr. Friday believes, lies one of the great opportunities of the profession.

PLANNING, expecially long-range planning, is not likely to have much effect on the course of business during the three years immediately ahead of us. This period will be one of recovery from the extreme low points reached in the summer of 1932. The rate at which that recovery proceeds and the length of time that will be required for return to a normal state of production and trade depend on factors quite other than the presence or absence of a plan. At the present moment these factors depend on nothing more radical than the restoration of public credit in national, state, and local governments through the balancing of budgets. If this is accompanied by sanity in international commercial relations, and by a general avoidance of such policies as were pursued in Europe during the spring of 1931, the revival should proceed rapidly during at least the latter half of 1933. Once initiated, the increase in production and employment should continue with but slight interruption for several years.

To this process, planning will contribute little. Our system, individualistic and unhampered as it is, works well to restore production and trade after such a decline in business and prices as we have experienced during the last three years. Its very nature gives it a capacity for quick adjustment, for the grasping of every opportunity, and for the development of new markets, products, and devices, such as a planned economy could never have. Once depression has run its course to the point where prices and costs are thoroughly deflated, no system can compete with the present one in its ability to bring about rapid revival. The experience after the major depressions of the seventies and the nineties proved this. The revival that began in 1879 was incredibly rapid and carried us to a state of exuberance before the close of 1880. After the depression which ran from 1894 to 1896, the revival was so rapid that by 1898 it was universally conceded that times were good once more. The same thing will happen this time.

DEMAND FOR GOLD ABNORMAL

If the present era of recession and deflation should be followed by a protracted period of rising prices, as was the rise after 1897, comparatively little will be heard about planning. Or, at least, such plans as may be made will have but slight effect on the course of business. It is more than likely that we shall see just such a period of rising prices. The present deflation in commodity prices was undoubtedly very closely related to, and caused by, the utterly abnormal demand for gold in the four years following the legal return to the gold standard by France. When that event occurred in June 1928, France, Belgium, the Netherlands, and Switzerland together held $1,500,000,000 of gold. In June 1932, when the withdrawals from the United States ceased, those countries held $4,500,000,000. This was an increase of three billion dollars, half of which was acquired between the announcement of the Hoover moratorium in 1931 and the cessation of gold withdrawals in June of last year. These four nations had a population of only 61 million people. They did not draw the gold because they needed it for monetary uses or as a basis for bank credit. They wanted it as a "storer of value." In an unstable world, gold was the one commodity of which the price was certain and the market unlimited. They will not hold this gold long after business recovery gets under way. Much of it is kept as a reserve behind deposits for foreigners who have left their money in those countries for safe keeping. When depositors withdraw their funds from those nations that have served as repositories for exported capital, gold will flow out. The United States has already recovered more than 600 million dollars of the gold that it lost during the year following the Hoover moratorium.

In addition, the world has again reached, and indeed exceeded, its highest previous point of gold production, and it is practically certain that this record will be broken during 1933. Moreover, India has exported more than 300 million dollars of gold during the last three years. In the past it was a tradition that she absorbed gold for hoarding. Now she has de-hoarded an incredible amount of the metal, and is still continuing to do so. As a result of all these factors, the banking reserves of the world should experience an addition to their gold supplies during the next two years that will be altogether unprecedented in history. The process has been under way for six months already. It is a safe prediction that the three years beginning with last June will see an average addition to the gold reserves of banks and governments of at least a half billion dollars annually.

This process should have the same effect as did the increased supplies of gold after 1896. That is, it should give us a steadily rising price level for some years to come. Under such conditions business will be active and the spirit of business enterprise will be adequate to keep production large.

PLANNING—A STABILIZER

During such periods of advance under the stimulus of business recovery or rising prices, planning is almost certain to be neglected unless the necessity for it is stressed and kept before the public. Its end is not progress in the development of productive efficiency. As a promotor of production it can never hope to compete with the system under which business has been operating in this country and in the Western World for the last century. It might almost be said that the time at which formal planning should be introduced into the

economic process depends on the point at which we want to freeze the stream of industrial progress. This no doubt is an overstatement, but it is certain that the stream of production would rise less rapidly after the initiation of planning than before.

Planning aims at stabilization. That it could have accomplished much in this line had it been in effect during the years 1925–1932, there can be little doubt. We have added something to our knowledge during the depression of 1929–1932. We know in which industries and in which lines of production the great shrinkage occurs. It is in the production of "durable goods," such as automobiles, machinery, buildings, and other construction. In these lines the level of output in 1932 was less than a third of what it was in 1929.

It is at this point that the problem of stabilizing through planning must be attacked. Had we had the requisite knowledge of the economic process, and had we applied ourselves to the task, we could have done much to stabilize construction, for example, even by planning our public works expenditures better than we did. During the eight years 1925–1932 inclusive, the total of this type of industrial activity amounted to $22,500,000,000. Its low point before the depression was $2,460,000,000 in 1926. It rose to $3,350,000,000 in 1930, and it fell to $1,900,000,000 in 1932. If these expenditures had been held at two billion dollars a year during the first five of these years, and had then been increased by regular steps to four billion in 1931 and 1932, their total would have been practically the same, but they would have had a great stabilizing effect on the construction industry as a whole. Even if all other construction had remained unchanged, the fluctuation between the high level of 1928 and the low point of 1932 would have been greatly narrowed down. As it was, construction fell by seven billion dollars during the four years that intervened between those two periods. Had planning been applied in such manner as to bring about the change in public construction just suggested, the decline would have been only four billion dollars throughout this period. The construction would have been a billion dollars less in 1928 and two billion dollars greater in 1932. Instead of four billion dollars of construction during the past year, there would have been somewhat over six. There can be no doubt but that this would have had a marked influence in stabilizing industry. It would not, of course, have kept us on the high levels of the boom years in this industry, but it would have filled up a very considerable part of the trough of the depression.

FEDERAL CONSTRUCTION AT HIGH LEVEL

It is interesting to note in passing that the Federal Government, in its construction activities, has pursued a well-nigh ideal program. Its expenditures for this purpose amounted to $225,000,000 in 1926 and to $600,000,000 in 1932. On the other hand, states, cities, and counties, which were spending $2,200,000,000 in 1926, increased that expenditure to practically $3,000,000,000 in 1930 and dropped it to $1,300,000 in 1932. If they had followed, even in part, the course pursued by the Federal Government, the effect would have been marked.

Such plans for the mere mitigation of the fluctuations in business activity will seem entirely inadequate to many people. They want a leveling out of productive activity, and to them planning should keep that end in view. It may as well be frankly recognized that such a leveling cannot be accomplished as long as the world wants goods as much as it still does. The best that can be done is to cut down the peaks and bridge the deepest chasms of business fluctuations. For in all our plans for economic betterment we must never forget that we are still in the midst of the greatest "plan" that the economic world has ever seen or undertaken. It is a plan for the exploitation of the secret forces of nature and for their utilization for the economic ends of humanity. This plan has been in active operation for 175 years. It began with that era which gave rise to the movement commonly designated the "Industrial Revolution," which got under way in England almost two centuries ago. It was greatly accelerated by the advent of steam transportation. During the last 50 years, since electricity has been in practical economic use, and especially during the last 20 years, it has been in its most intensive stage. That plan is by no means finished, and its characteristics give us the setting for the practical discussion of economic planning.

PLANNED CONTROL OF CHANGE, NOT STAGNATION

"Stabilization" is in some ways an unfortunate name for the thing that we expect to accomplish by a planful ordering of the economic process. That word connotes fixation. What we are after in the world today is not fixation of either the size or the composition of our flow of products. What we want is rather a planned control of change. For change is the dominant and distinguishing mark of this era in which we are living and which is now approaching the end of the second century of its history. We want the benefits of change, but we should like to mitigate its costs, especially those that present themselves in the form of industrial depression.

But despite these costs, the economic benefits of the system are so great that neither we nor the world in general will be willing to forego them for some decades or even centuries to come. The most stable, and indeed the most striking aspect of the curve of industry for the last century during which we have been operating under this system, is its constant upward trend, indicating an increase in all those economic goods that man so much desires and so earnestly strives for. All the depressions that have been so much deplored, appear rather trivial when one scans the curve of economic production for the period as a whole. In the United States this system has carried us to great heights of economic well-being. Witness only the single fact that the labor of 22 per cent of our people is adequate to feed us, to supply enough cotton for our own textile needs and for those of 150 million other people, and to provide us with some other textile fibers besides. At the beginning of this era, 80 per cent of the population of every country was completely absorbed in the problem of supplying food and the elementary textile fibers.

This primitive state of things still prevails in such countries as Russia, India, and China. We are apt to forget that we ourselves were once at that stage and that it has been only through the operation of our present "planless" system that we have attained to our present level. And the end is not yet, either for us or for those who are patterning their systems after ours. But our productive efficiency and our output have now reached a point where we are probably beginning to set greater store by stability than by further increase in the rate of acceleration.

Certainly we are convinced today that it should be possible to operate this system with smaller fluctuations in productive output. And it should not be beyond our ingenuity to do this without sacrificing materially our rate of progress in technological development.

These last three years have seen the volume of production of durable goods decline by two-thirds. In the realm of non-durable commodities it has fallen only by 20 per cent. That localizes the problem.

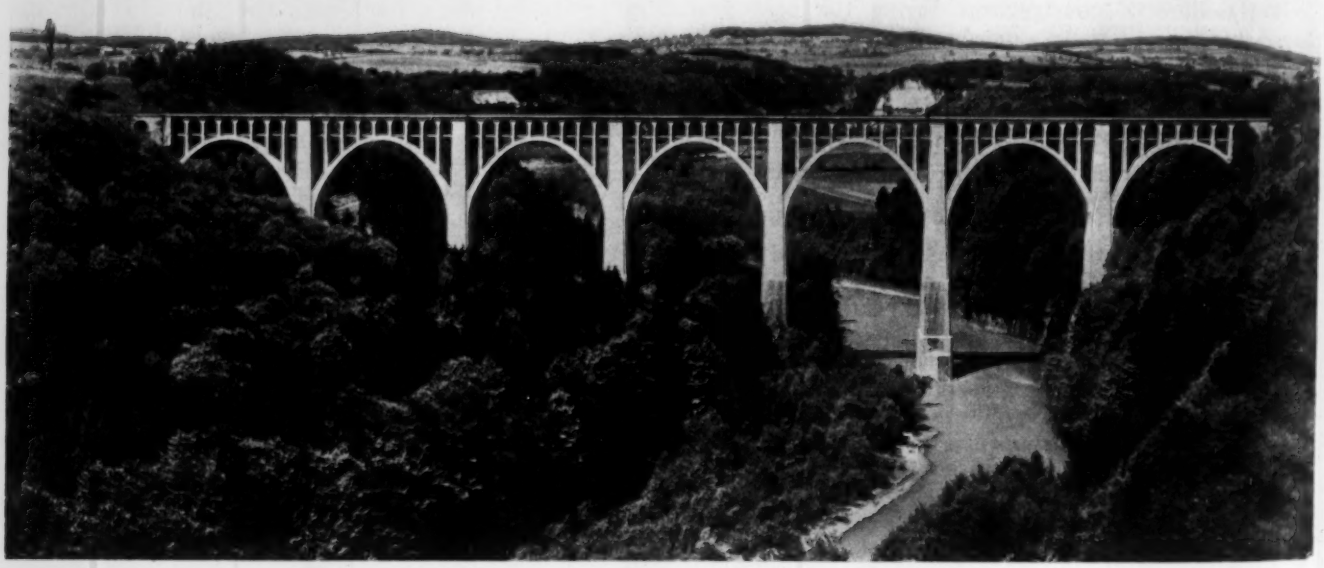
DETAILED STUDIES NEEDED TO FORECAST TRENDS

These fluctuations are caused very largely by economic changes, both in methods of production and in types of product. One of the reasons why we have these depressions, which are so disastrous to the individual and to the business concern, is that we lack foresight as to the manner in which new factors develop and operate within the economic and financial system. The most valuable work that can be undertaken for economic planning and industrial stabilization is a study of the nature and the laws of change.

Certainly no period has ever offered such an abundance of material for the pursuit of an investigation of these laws as has the last century. How long does it take a new product, whether it be for use in further production, for transportation, or for ultimate use and enjoyment, to establish itself within the system of economic life? The statisticians have done some rather cursory work on growth curves. But anyone who has ever looked into these interesting pictorial products of the statistical mind must have been impressed by the meagerness of the investigations. Yet there is no such thing as intelligent planning, or even of informed conduct of business, unless we know what changes are impending and over what length of time they will operate. For engineers such studies offer a field of research and investigation which stands at the head of all others in importance for solution of the problems of planning and the rational conduct of business.

A single example will suffice to clarify what is meant by this assertion. The motorization of our population is certain to have far-reaching effects on the redistribution of that population. This, in turn, is bound to influence urban real-estate values. It seems clear to the observing person that the business sections of all our cities, and especially of the older ones, are entirely unsuited to the needs of a motorized population. No city has ever yet been built to serve that need. What is the engineer's plan for remedying this obsolescence of our cities and of their streets? What changes in the size and distribution of real estate values will occur during the next 20 years as a result of the fact that this new means of transportation has made available to the city dweller probably 25 times as much land as was available at the beginning of this century? What is the significance for the future of the fact that milady who goes shopping no longer demands that the emporiums of trade be within walking distance of each other, but rather that they have an abundance of convenient parking space? What changes will occur in the location and distribution of our retail marketing areas as a result of these facts? These are all questions that the financial public has a right to address to the engineer. Can he answer them? Can he tell the banker, or the life insurance company that consults him professionally, whether their institutions should get rid of their real estate mortgages in the business section of their cities?

If he cannot answer these questions, how is he in a position to give much valuable assistance in this problem of planning? And yet we need planning in order to enable us to exercise some rational control over industrial developments. Engineers can make their greatest possible contribution to the future stabilization of business by their studies of change and the basis which such studies will furnish for detailed long-range plans. There is no possibility of controlling change unless we know its laws.



GRAND FEY VIADUCT, NEAR FREIBURG, SWITZERLAND

Swiss railroad engineers incorporated the old sandstone and cast-iron piers of the original structure in this reinforced concrete viaduct. It is noteworthy that continental engineers take advantage of, and preserve, the natural beauty of the landscape in their construction. This structure has an over-all length of 1,300 ft, made up of seven 140-ft arches, which carry two tracks 246 ft above the river bed. The photograph is reproduced by courtesy of Adolph Buhler, Chief Engineer of Bridges, National Swiss Railways.

Some of the Problems of the Railroads

By R. E. Dougherty

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RAILROADS have been regulated and controlled as though they were a monopoly, whereas now they suffer from free competition by highways, waterways, and to a lesser extent, by airways, and all these competing types of transportation benefit by some form of public subsidy. Mr. Dougherty points out that the truck and the automobile pay but one-third of the cost of the highways. Owners of real estate, and among them the railroads, which constitute some of the largest of such owners, must carry the burden of the other two-thirds of the cost. Then, too, the railroads have been saddled with such non-revenue-producing expenditures as grade separations, changes in railroad structures to accommodate waterways, monumental station developments, electrification, and valuations for rate-making purposes. The railroads may be expected to remain the transportation backbone of the country, but wasteful duplication of existing facilities and excessive competition must be eliminated. The paper from which this article was prepared was presented on January 18, 1933, at the General Session of the Annual Meeting of the Society.

IN discussing the railroads, we are considering one of the largest industries in the country, second only to agriculture in extent and number of individuals affected. The Class I railroads, which include those with an annual gross revenue of over one million dollars, operate approximately 230,000 miles of railroad, approximately 93 per cent of the mileage of the country, and earn about 97 per cent of the total gross revenue of all railroads. There are 162 Class I railroads, and of these 106 failed to earn their fixed charges in 1932, and only 29 paid any dividends whatever. For the first nine months of 1929 these roads earned in gross revenue $4,781,000,000, and for the first nine months of 1932 they earned $2,363,000,000, or a decrease of nearly 51 per cent. We might express these figures in another way by stating that this decrease in revenue has meant nearly $9,000,000 daily.

The trend of traffic indicates a decrease of about 35 per cent in the number of revenue passengers handled and nearly 53 per cent in revenue freight tonnage for the corresponding period. This has meant a release from railroad service of nearly 700,000 employees. The purchase of material and supplies decreased from $1,329,000,000 in 1929 to $442,000,000 in 1932, a decrease of 67 per cent. These figures do not include construction projects under lump sum or unit price contracts, nor do they include equipment purchases.

All possible expenditures requiring capital investment have been stopped, and the work now in progress is only that which is absolutely necessary from the standpoint of safety, or possibly that which may be under contract on Federal or state order. Standing forth prominently in this last-mentioned category are the eliminations of grade crossings.

The ten-year period following the end of Federal control in 1920 has shown probably a greater advance in railroad efficiency and economy of operation than any other similar period. Railroad operators have realized that the industry has been undergoing rapid transformation and, further, that every effort must be made to meet competition by showing increased efficiency in serving the public. This is evidenced by faster train schedules, longer trains, improved power, labor-saving devices of all sorts, saving of fuel, and improved terminal facilities for freight and passengers. In addition to these improvements, many non-productive improvements have been necessitated by public demand and other related reasons. This program of development has required large capital expenditures. In this decade the Class I railroads spent about $7,500,000,000 in improvements.

The question arises as to the underlying causes for the present condition. Coupled with the general economic situation, which is affecting all industry, is the factor of subsidized competition from vehicular traffic on the highways, waterways, and to a limited extent, thus far at least, the airways.

SUBSIDIZED VEHICULAR COMPETITION

The private passenger automobile has been the chief contributor in almost eliminating short-haul passenger travel except commutation. Statistics show that 1920 was the peak year for railroad passenger travel, and that in 1932 it was approximately only 35 per cent of the maximum. During the same period, between 1920 and 1932, the registration of private automobiles increased by 150 per cent. The peak of freight operation was in 1929, and the decrease in 1932 was about 50 per cent. During the past decade, motor truck registrations have increased from 1,000,000 to 3,500,000.

The railroads have made strenuous efforts to retain passenger travel, especially the long-distance hauls, which for a time at least were not so seriously affected by the automobile. The records of certain of the roads prior to 1929 show that passengers formerly desiring berths in Pullmans were only content with rooms, those riding in day coaches preferred the Pullmans, and the demands for upper berths decreased considerably, so that while the number of passengers decreased and the revenue decreased, the number of cars handled was not reduced in anything like a similar ratio.

The development of the automobile has been made possible by the tremendous expenditures for highway improvements and the fact that the automobile is subsidized to the extent that it is required to pay only approximately one-third of the annual costs incident to the highway systems, excluding city streets, the remaining two-thirds being assumed by the taxpayers, including the railroads. The automobile, therefore, is not self-sustaining, nor does it contribute to the general costs of government. Some may question the advisability of increasing the burden on private automobiles, but certainly the use of the public highway for profit by buses and motor trucks in competition with the railroads, with their tremendous investments, has developed a situation that should be speedily corrected, especially since among the multitudinous holders of railroad securities are our basic financial institutions.

The necessity for relief from the burdens placed on real

estate certainly evokes the inquiry as to why there should not be a fair competititive relationship and why the automobile should not pay for the cost of the highways, including interest, depreciation, and amortization of capital expenditure. This form of transportation should furthermore be subject to governmental regulation similar to that exercised over the railroads by the Interstate Commerce Commission and the state commissions, to such extent as may be necessary.

WATERWAYS ALSO BURDEN TAXPAYERS

It seems to many railroad men that the competition from waterways, while perhaps not as extensive as that from motor vehicles, is even more unreasonable. It is difficult to gage the economic basis which justifies any waterway expenditure of magnitude. At the consummation of the treaty with Canada for the St. Lawrence Waterway, there emanated from Washington certain expressions of opinion of considerable interest to the railroads, particularly the statement that the waterway would require ten years to complete and that "during this time the normal growth of the country's traffic will compensate for any diversion from American railways." There also appeared the statement that many of the states in the Middle West, particularly in the agricultural sections, extending as far east as Pennsylvania and New York, comprised a section that has "always been under national transportation disadvantages in the exportation and importation of commodities." It is hard to see what consideration has been given to the position of the railroads in the development of the St. Lawrence Waterway project. It is also difficult to realize how Canada, with its tremendous railroad problem, can justify its participation. The St. Lawrence Waterway, if completed, will probably be the world's greatest part-time transportation facility, being able to function possibly seven months per year at most, leaving with the railroads the transportation responsibility for the remainder of the year.

The New York State Barge Canal is a specific instance of a development of this character and its status can best be described in the words of the Superintendent of Public Works of the State of New York in a report to the Governor in 1926, reading in part as follows:

> The greater part of the tonnage (canal tonnage, 1925) was bulk freight—grain, sulfur, salt, etc.—which is carried at low rates both by water and rail; a fair average rail rate on the commodities carried by canal from Buffalo to New York, the longest haul, is $3.70 per ton. In 1925 it cost the State $4.51 per ton for all freight floated on the Canal, regardless of length of haul. From these figures it is evident that it would have been cheaper for the State if all the freight carried on the Canal had been put in railroad cars and the State had paid the freight bills.

The cost of transportation between New York and Buffalo by way of the State Barge Canal would approximate at least twice the cost of rail transportation if all costs are included. Nearly 3,700,000 tons moved over the Barge Canal in 1932, the maximum in any year since the last enlargement of the Canal was completed in 1918. It can be roughly estimated that this operation in 1932 has taken 13 or 14 million dollars from the revenue of the railroad. Shippers are undoubtedly taking advantage of the cheapest and slowest form of transportation and are not worried about the fact that the surplus cost is borne by the taxpayer.

It would also seem that consideration should be given to a revision of rates through the Panama Canal, a large proportion of which are paid by foreign shipping, so that the railroads may be placed on a fairly competitive basis for transcontinental business. In connection with the increased use of air mail, a statement made by the Postmaster General in June 1931 is of interest. It is to the effect that "The postage which you attach to your air mail letters defrays less than half the actual cost." From 1926 to 1931 the number of airplanes multiplied five times and the number of pounds of mail carried annually increased from 700,000 to 9,000,000.

No railroad officer can properly desire the elimination of attractive and efficient forms of transportation desired by the public, but, on the other hand, they are certainly justified in calling attention to the various subsidies which these competitive forms of transportation enjoy, largely at the expense of the taxpayer.

Many of the railroads, such as the New York Central, are the largest individual taxpayers in the states which they traverse, and this is particularly true in the larger cities. The total taxes for the New York Central Railroad this year will exceed $32,000,000. In 1931 almost 32 cents out of every dollar of net operating revenue of the Class I railroads was paid in taxation for the support of the national, state, and local governments, and for the first nine months of 1932 nearly 43 cents out of every dollar of such revenue was so spent.

NON-PRODUCTIVE EXPENDITURES

In the decade just passed, the railroads have been confronted with public demand for many non-productive expenditures, such as extensive station development, elimination of grade crossings, electrification, changes on account of public drainage and waterway projects, valuation of its physical properties, etc. Station developments perhaps can be dismissed with the opinion that with the completion of certain projects now under construction, the last monumental railroad station has been built in this country for some time to come.

The question of elimination of grade crossings, however, is indeed a difficult one. The burden that might be placed on the carriers as a sequel to this type of development may be judged by the fact that if all the grade crossing projects under construction, under order, and under active discussion in New York State alone, were to be carried to a conclusion, it would mean an increased obligation on the part of the New York Central Railroad Company of $60,000,000, or approximately 10 per cent of its total bonded indebtedness.

Other railroads, particularly those operating through closely populated centers, are faced with similar problems. The laws vary in the different states. Probably the division of cost in New York State—50 per cent to be paid by the railroad, 49 per cent by the state, and 1 per cent by the county, with the possibility of borrowing moneys from the state at low rates of interest and amortization over 50 years—is as favorable an arrangement as any. All grade crossing programs are in need of radical revision and curtailment so that not only the burden upon the railroads but upon the states themselves shall be substantially reduced.

When municipalities are largely relieved of the financial burden they become extravagant in their demands. It is further realized that demands for grade separation arise with greater frequency from complaints of delay and interference to automobile traffic than from considerations of safety.

The vast increase in motor vehicle traffic as compared with railroad traffic justifies the opinion that the burden for grade crossing elimination should be shifted to more nearly accord with the benefits enjoyed. Railroad companies should not be required to assume 50 per cent or more of such costs as rebuilding overhead structures to permit heavier trucks or to provide four-way auto-

mobile lanes where a two-way structure already properly serves the purpose, if care were used in operating the automobile. Proper legislation would place the same respect in the hearts of automobile drivers for flashing lights and similar warning signals at grade crossings as they now feel for a signal on Fifth Avenue, New York, in front of a traffic officer.

Railroads should be relieved from any increased taxation incurred as a sequel to grade crossing elimination.

Public service commissions as a whole are fully aware of this situation and are handling it with great intelligence, but nevertheless they are governed by laws that should be changed.

Many waterway improvements impose large burdens on the railroads for changes in the structures at crossings, involving widening of bridges and elevation of tracks. Certain new waterway projects under consideration in the Chicago, Pittsburgh, and Youngstown districts would, if consummated, involve expenditures for changes in railroad structures of $160,000,000. It is to be hoped that those responsible for the development of these projects will give due consideration to such factors.

Electrification is in many ways a most comfortable form of railroad operation. Although it may produce certain operating economies, the volume of traffic must be exceedingly dense to justify the investment.

VALUATION OF RAILROADS AND RECAPTURE

Congress passed the Valuation Act in 1913, the idea then being prevalent that the railroad industry was overcapitalized, and that this fact would be revealed by valuation. This idea has long since been exploded, but valuations of 1,685 steam railroads have been completed and 50 per cent of the work of complying with the subsequent requirements of Congress, and of bringing the valuations down to date has been done. The total cost of valuation to date has been $178,000,000 for all railroads, of which the carriers have borne approximately $138,000,000.

The Transportation Act of 1920 passed by Congress, introduced a new element involving valuation. The act provided that in any year one-half of any income in excess of 6 per cent on the fair value of a railroad property should be recaptured from the railroad and paid into the United States Treasury to be used to assist poor railroads. The other half of the income in excess of 6 per cent was to be placed in a reserve fund of the railroad to be used for the payment of return on securities in any year in which the earnings were less than 6 per cent. During the year 1929, the net railway operating income of all Class I railroads of the United States was 4.84 per cent of the investment, and during the year 1931 it was 2.00 per cent. The Interstate Commerce Commission has urged the repeal of this recapture provision.

The question of consolidation of the railroads has received a vast amount of study by the Interstate Commerce Commission and by railroad officers. This study culminated in a plan issued in December 1929 consolidating the railroads of the country into 21 systems. Various revisions have been made in this plan and further consideration has been given to it by the railroad officers involved. A problem arises as to the allocation of numerous short lines, between 30 and 50 being assigned to the various systems. Many of these short lines have for years operated at a deficit, and the original justification for their construction has disappeared. In determining final action, this particular question must be handled with great care in order to avoid an excessive burden on transportation costs. Consolidation possesses certain advantages, but on account of present financial conditions it is difficult to determine how and when further progress can be made.

The advisability of abandoning various branch lines has been given a great deal of study. Increasingly sympathetic consideration is being given the subject by state and national commissions. Over 8,000 miles of lines throughout the country have been abandoned within the last ten years, and over 1,400 miles were authorized for abandonment during the year 1932. It is only in extraordinarily aggravated cases that no objectors appear, and it does not take any vast amount of objection to prevent, or at least delay, an abandonment.

SURPLUS OF TRANSPORTATION FACILITIES

The railroads are not through, by any means, as the transportation backbone of the country. It is my belief that not only railroad officers but public officials throughout the country, including legislators, are earnestly seeking the proper solution. The railroads are intensively studying their problems, including the advisability of coordinating truck haul with railroad haul, of instituting pick-up and delivery service, of utilizing new types of equipment, and otherwise improving the service. Whether or not pick-up and delivery service would simply mean an added financial burden on the railroad, without a compensating return, is a question that remains to be answered, but at any rate the railroads are giving it attention and adopting it in certain instances.

Railroads have not been different from other forms of industry in developing competition, sometimes by duplication of effort and expense, but there has never been a time when the officers of the railroad systems have been cooperating to a greater extent and to greater advantage than at present in the elimination of waste.

Considering the situation broadly, and particularly from the standpoint of the engineer, the opinion may be ventured that everyone responsible for future development will have to exercise a keener sense of economics, particularly when considering competitive projects. There is no question but that there is a surplus of transportation service at the disposal of the public, even under the most prosperous conditions. There is, however, practically no form of development of which the same comment may not be made—for example, vehicular bridges and tunnels across rivers, office buildings, hotels, apartment houses, coal operations, with their competitors of oil, natural gas, etc. Almost any industry may be included in the general statement.

In many instances our field of vision has been much too narrow. We must recognize that our interpretation of progress and competition in the last decade has demanded extensive duplication of facilities and efforts. The public has been too prone to call for facilities for which no one can afford to pay.

Past experience seems to justify the opinion that little omnipotent vision is given human beings for prophesying the future, although engineers should, by training, be possessed of as much of this attribute as anyone. Extreme care must be taken in developing public or private improvements, certainly for any period of time that can be immediately visualized, in order to prevent duplication and new construction tending to dilute the operating economics of already existing developments, whatever they may be, especially when they involve the investments of many of our fundamental financial institutions. No real solution of our problems can come except through complete cooperation between all sections of the country and all forms of industry, with the objective of reducing excessive competition.

Grade Separations for Railroads

Some Recent Designs to Cut Costs and Methods to Facilitate Construction

SIMPLE railroad grade separations are expensive. More tracks, wider streets, long approach fills, traffic maintenance, moving of signal systems and third rails, additional rights of way, damages, and other items all add greatly to their cost. As a rule, the railroads are required to pay a substantial part, up to one-half, of the cost. The people of New York State alone voted $300,000,000 in bonds to be matched by an equal sum by the railroads. The total bill for grade crossing elimination in the United States is a staggering sum. The following articles were prepared from papers read on January 19, 1933, before a joint session of the Construction and Structural Divisions of the Society at its Annual Meeting in New York. In the first, Mr. Vogel discusses from a background of experience with the Delaware, Lackawanna and Western Railroad, the relative costs and advantages of various structural designs. In the second, Mr. Wilsey points out the numerous difficulties that confront the contractor in the construction of railroad grade separations under heavy traffic and in cramped quarters.

Structural Design of Economic Types

By J. L. VOGEL

MEMBER AMERICAN SOCIETY OF CIVIL ENGINEERS

BRIDGE ENGINEER, DELAWARE, LACKAWANNA AND WESTERN RAILROAD, HOBOKEN, N.J.

WITH the increase in automobile traffic and the mania for speed, which has made drivers more careless, the problem of railroad grade separation has become paramount. It has been necessary for the governing bodies of the various states to consider this great problem and to bring it before the people in the form of bond issues to supply the funds necessary to carry out a program of grade crossing elimination. A few years ago a number of states successfully voted the necessary funds. In New York State alone, the bond issue was for $300,000,000, and the various railroad companies operating in the state were required to raise a like sum to carry out the adopted program. According to a recent report of the American Railway Association, the burden placed on the railroads of the United States for grade crossing separation and protection amounts to practically $288,000,000—the beginning of a non-productive expenditure covering only the five-year period from 1927 to 1931, inclusive.

This problem is complicated by the fact that the railroads are supervised by various governmental agencies which have fixed the requirements as to roadway width, alignment, grades, and underclearance. Thus the railroads have found it essential to make a thorough study of each grade crossing elimination in order to reduce the expense as much as possible.

In designing a single crossing, the main factors involved are alignment, grade, drainage, track changes, floor depth, underclearance, maintenance of traffic, railroad expansion, and elimination of future maintenance. In projects involving more than one crossing, the additional factors to be considered are the possibility of combining streets for the purpose of closing part of the crossings, the utilization of adjacent property for industrial occupancy, and the probable damages accruing as a consequence of changes in street grades.

While hearings were being held by the Public Service Commission of New York in connection with the general project of grade separations through Elmira, N.Y., the question of the type of structure to be used at the

Four Tracks Carried Over Broad Street in Clifton, N.J., on Four Spans

Two Tracks Carried Over Harrison Avenue at Kearny, N.J., on a Single Span

Which Cost the More? See Text

TWO TYPICAL GRADE SEPARATIONS ON THE DELAWARE, LACKAWANNA AND WESTERN RAILROAD

various streets was discussed. Because of the burden of cost placed on the railroad, the economics of the project was of the utmost importance. There was considerable opposition from the state and city officials to a type of bridge having a bent or a line of columns in the center of the roadway. It was clearly demonstrated, however, that such a pier or line of columns was beneficial in city streets where travel is more or less regulated. In addition, proof was given of the success of this type of structure as used elsewhere and it was definitely shown that the economy secured was considerable. To illustrate the truth of this statement a comparison of two actual structures will be given, both built by the Lackawanna Railroad in New Jersey in 1926 by the same contractor, the work being awarded by competitive bidding.

PART OF GRADE SEPARATION PROGRAM, ELMIRA, N.Y.
Such Bridges Saved 100,000 Cu Yd of Fill

SINGLE-TRACK DECK PLATE-GIRDER SPAN
Over Route 30 at Hampton, N.J.

At Kearny, N.J., the Harrison Avenue separation carries two tracks on three half through plate girders over that thoroughfare in a single span 93½ ft long. The structure was designed for E-65 loading, according to the specifications of the American Railway Engineering Association, with a solid floor and girders 17½ ft apart. The clear span between abutments is 86.0 ft. The actual cost of the bridge structure, not including excavation, was as follows:

Concrete, reinforcing steel, sheet copper joints, and waterproofing	$30,039.81
Structural steel	29,260.89
Painting	738.39
	$60,039.09
520 cu yd of Class B concrete for additional depth of foundations (deducted to make structure comparable with Clifton separation)	9,880.00
Total	$50,159.09

The second structure, over Broad Street in Clifton, N.J., is a four-track reinforced concrete bridge of four spans, utilizing girderless flat-slab construction. The over-all length of the bridge in line with the tracks is 116 ft 1½ in., and the distance between neat lines of abutments, measured parallel with the tracks, is 108 ft 4½ in. The width of the street is 70 ft.

The width of the bridge is 59 ft, including the balustrades. This structure was also designed for E-65 engine loading. The actual cost of the bridge structure, not including excavation, was as follows:

Concrete	$21,426.00
Balustrade and waterproofing	4,583.67
Reinforcing steel	5,703.25
Total	$31,712.92

By using the girderless flat-slab structure, the saving obtained was $50,159.09 − $31,712.92 = $18,446.17. Thus a four-track concrete separation cost 37 per cent less than a two-track steel structure. These two structures are shown in the accompanying photographs.

This and other examples indicate the considerable saving possible by the use of reinforced concrete for a girderless flat-slab structure. There is also a material saving in the required width of railroad roadbed, in reduction of street excavation, and of fill (if required), as the floor thickness can be kept down to a minimum. This type permits the railroad tracks to be maintained at the normal interval of 13 ft between centers. Where bridges are constructed in close proximity to railroad stations or where switching operations are carried on, the girderless flat-slab type eliminates all obstructions or hazards between tracks and permits safe operation for both men and trains.

A SEPARATION PROJECT IN ELMIRA, N.Y.

A very interesting grade separation has recently been completed in the city of Elmira, N.Y. The improvement consisted of a track revision of about 2½ miles, of which a half mile was in the main yard of 40 tracks. The operation included the raising of a two-track through riveted truss bridge 143 ft long over Newtown Creek about 3½ ft; construction of an overhead highway viaduct at Water Street; undercrossings at East Church Street, Sullivan Street, Madison Avenue, Lake Street, and East Washington Avenue; retaining walls and fill between these streets; and several by-passes from streets that the city agreed could be closed.

The adoption of the girderless flat slab for bridge crossings gave great economy in the bridges themselves. In addition, the greatly decreased floor depth reduced the difficulties in modifying the track profile, with the result that there was also a great saving in fill yardage. The maximum rise over the 2½ miles is only 12 ft despite the fact that the permissible depression at the various streets was found to be limited because of the high ground-water level resulting from the proximity

OVERHEAD HIGHWAY CROSSING AT KANONA, N.Y.
Through Plate Girder of 94-Ft Span; Concrete Approaches with Two-Way Reinforced Slab

of Newtown Creek and the Chemung River. Therefore it was necessary to elevate the tracks the amount necessary for clearance and floor depth.

Each inch of additional rise in track level meant at least 6,000 cu yd of additional fill for the freight yard alone. If a design consisting of a one-way reinforced slab, continuous over supports, had been used, an additional 15 in. of slab thickness would have been required, entailing an increase of about 100,000 cu yd in the fill in the yards as well as an additional 400 ft in the length of freight yard affected, all this aside from the intervening fill and height of retaining walls between streets. The selection of the flat-slab girderless type was thus amply justified. The illustration gives a clear conception of the general character of the work, especially that near the passenger station.

Another project of interest in this connection included three bridges made necessary when the New Jersey State Highway Commission built a new section of Route 30 from Hampton, N.J., through Washington, N.J. This project did not separate any existing grades but established three additional crossings. Although these were of no benefit to the railroad, it was required to pay half of their cost.

Of these three bridges, that at Hampton, which is illustrated, is particularly interesting because of the unusual box-type abutments used. The bridge is a single-track structure of the deck plate-girder type with a concrete slab floor. Although the distance between curbs, measured at right angles to the highway, was but 56 ft, the crossing angle of 35 deg 34 min necessitated a length for the steel span of 103 ft 2 in. from center to center of bearings. At each end of the main girders a reinforced concrete cantilever back wall was constructed to retain the fill. Due to the height of 35 ft from footing to base of rail, a special type of construction was used. This consisted of a reinforced concrete box, with walls 2 ft thick and wing walls of the semi-gravity type. A considerable saving was secured by using this construction instead of a gravity or semi-gravity type of abutment.

HIGHWAY BRIDGES OVER RAILROADS

At Kanona, N.Y., the overhead highway bridge illustrated consists of a plate-girder span over the main line of the railroad, with reinforced concrete approaches, providing an unobstructed roadway 30 ft between curbs. The angle of crossing is 42 deg 30 min. The distance between the face of the piers, measured at right angles to the tracks, is 59 ft and the distance from center to center of bearings of the main girder span is 94 ft. The length of the viaduct is 335 ft. The concrete approaches are slab spans of the two-way reinforced type, the concrete bents being 32 ft from center to center. The bents are composed of two reinforced columns 2 ft 3 in. square, and cross girders 2 ft 3 in. by 3 ft 10 in. The side or longitudinal girders for supporting the slab are $1\frac{1}{2}$ by 5 ft in section.

It has been found by careful study that the two-way type of reinforcing for slabs is the most economical where column heights are not excessive and where foundation conditions are suitable. This type of construction is used by the Delaware, Lackawanna and Western Railroad at all sites similar to that of the Kanona overhead bridge and has received the approval of the state authorities. For heights of less than about 20 ft, fill approaches are more economical.

From the experience of the Delaware, Lackawanna and Western Railroad with grade separations in cities where traffic is more or less regulated, and where piers or columns in the center of the roadway are therefore permissible, it is concluded that the girderless flat-slab structure is the most economical and the most suitable when there are three tracks or more. Where railroad switching operations are carried on, the girderless flat slab is especially advantageous. Conditions may justify deck plate girders if underclearance permits. If underclearance is restricted and the use of center columns is prohibited, then a through plate-girder type with a solid floor should be adopted, and the girders will then be spaced 10 ft clear from the center line of the track.

For highway overcrossings on the main line of the railroad, a through plate-girder span on concrete open piers, of stiff-frame construction over the tracks, with concrete approaches having two-way reinforcement, is the most suitable and economical. For crossings over branch lines, where spans over tracks permit, the reinforced girder and T-beam type, flanked by concrete approaches with two-way reinforcement, is the most suitable and the most economical.

The general work of both design and construction of the structures referred to was under the direction of G. J. Ray, M. Am. Soc. C.E., Chief Engineer of the Delaware, Lackawanna and Western Railroad.

Construction Under Heavy Traffic

By G. H. WILSEY

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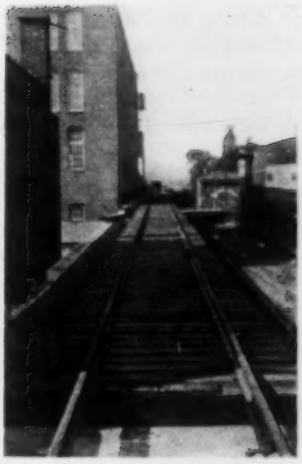
SINCE the first railroad was built about a hundred years ago, the problem of separating grades at crossings of highways and railroads has been with us. The motor car so increased highway travel that the need for grade separations became urgent; at present it is one of the most serious problems that confronts the railroads. In the construction industry it has become of major importance, for it has opened a large field to the railroad contractor. The construction of these separations is so different from the building of new railroad lines that a special method of attack has been found necessary.

Superficially, a grade separation job consists of track work, grading, and the construction of retaining walls and one or more bridges. There is, however, another item of major importance—the maintenance of traffic on both railroad and highway. It is this that can change a simple job into a tedious one which may take three or four times longer than would the same amount of work on new location. The maintenance of highway traffic is not as difficult a problem as the maintenance of railroad traffic. In some locations the crossing can be abandoned during the construction period and traffic detoured over other highways, although in others high-

One Track Removed; Excavating for Retaining Wall

Pouring Footing for Retaining Wall

Erecting Plate Girders; Notches Left for Trestle



One Track Raised on a Temporary Trestle

SEQUENCE OF TRACK RAISING FOR THE ERIE RAILROAD, PATERSON, N.J., 1930

way traffic must be maintained on the original location except, perhaps, for a day or two while an overhead bridge is being erected, especially if the bridge is of steel. Sometimes a temporary detour of moderate length can be built, crossing the railroad at grade. It is very seldom that railroad traffic can be detoured so as to permit the building of a separation as a unit. This is particularly true of the larger projects, involving two or more tracks and several crossings. Quite often it is necessary to elevate several tracks through a congested city district, where the right of way is not wide enough to permit detours, and in such a case the job must be done in steps by abandoning some of the tracks while construction is in progress. If the railroad is electrified, the complications seem to increase beyond belief, unless one has had experience on several jobs of that nature.

ELECTRIFIED LINES PRESENT COMPLICATIONS

As an example of the handicaps encountered on electrified lines, a project of the Long Island Railroad may be cited. The separation covered a distance of over a mile in Jamaica, L.I., and included the raising of eight tracks over ten streets. Jamaica is the bottle-neck of the railroad system, and between 600 and 700 passenger trains passed daily through the construction work. Because of operating conditions, the job was started on the south side of the right of way. Three tracks were left in place on the surface along the north side and the southerly tracks were removed.

Along the southerly line of the right of way there was a high-tension transmission pole line, carrying five three-phase circuits at 23,000 v and supplying the railroad system east of Jamaica. This line was to be replaced by an underground system in an 18-way duct line on the back of the south retaining wall; but first the wall had to be built and the bridges across the streets constructed. In places the wires came within 5 ft of the top of the wall. In other places the line was several feet north of the right of way, and as all operations had to be confined to the right of way, the wires were between the wall and the contractor's mixing plant. For a distance of about 1,500 ft the right of way was widened on the south to permit the construction of an island station platform, and the pole line came in the location of this platform, which is on concrete piles driven through the newly made fill. Of course, it was impossible to drive the piles until the pole line was down, and railroad traffic could not use the new work until the platform was built. Both the railroad company and the contractor made estimates on the cost of constructing a temporary pole line and found it excessive.

The retaining wall was built first, encasing the poles of the transmission line, concrete being poured from traveling tower mixers. Dummy wires were placed on cross arms below the live wires before work started and all employees were informed that they were live. The mixers were grounded with flexible conductors attached to the poles. The bridges were erected by setting the girders on the south ends of the bridge seats and jacking them along to position. Then the duct line was completed and construction work stopped while the new conductors were being pulled in and connected up. After that the platform was completed and the traffic shift made. If it had not been for the transmission line, the first part of the work could have been done in four months less time. Had the contractor not made a thorough study of this problem and allowed for it in his prices, the result would not have been pleasant.

Another feature of grade separation jobs involving electrified lines is the time consumed in placing the third rail and bonding the running rail. Also, the placing of signals on involved track layouts takes considerable time. Any progress schedule a contractor may make must allow for these items. In fact, all operating conditions have more bearing on the construction schedule than the construction items themselves, and come first in all considerations. This is well illustrated by the construction work now under way for the Long Island Railroad Company at Valley Stream, Long Island, N.Y. The work started on May 15, 1932, with the construction of detour tracks, but because of third-rail work and signaling, it was found that the detour could not be placed in operation until August 11, and no concrete could be poured before August 15.

COOPERATION WITH OPERATING COMPANY

In a great many cases, railroad companies prefer to furnish certain material and do a certain part of the work with their own forces. While no criticism is offered of these practices, at times they are very inconvenient for the contractor. He may find that his schedule does not fit in with the one the railroad company has made. Structural steel may be delayed several months

or it may be shipped too early, either causing a long delay during which no work of any kind can be done, or involving the expense of storage and rehandling. Even if the steel is delivered when wanted, it may not arrive in the order best suited for economical erection. The

TRACK ELEVATION AND GRADE SEPARATIONS AT JAMAICA, N.Y., ON LONG ISLAND RAILROAD, 1931

performing of certain parts of the work by those not under the jurisdiction of the general contractor generally results in expense of one kind or another. The ideal contract is one that embraces all the work to be done.

The raising of track under traffic is one item that the railroad company can do with its own forces without the contractor's making any objection, if rail traffic is at all heavy. There are too many uncertainties and unknown factors entering into such work for it to be at all desirable on a unit price basis.

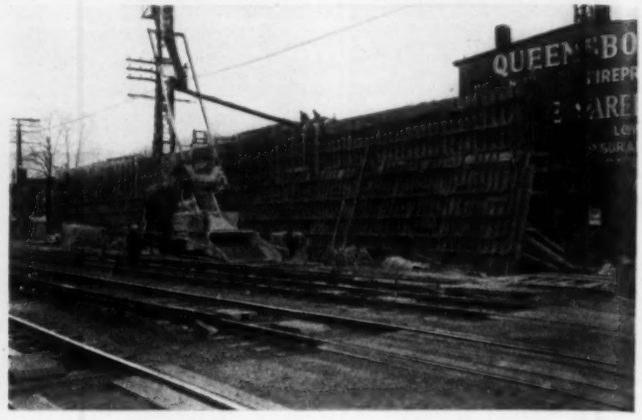
As a rule, railroad companies are entirely willing to cooperate with contractors in making changes in the method of doing the job as a whole, provided operating conditions are not interfered with and the cost is not increased. For example, the improvement in Jamaica was scheduled by the railroad company to be done in five steps. The fill, amounting to about 500,000 cu yd, was to be placed by rail haul. By changing to truck haul the contractor was able to do the job in only two steps, with a large saving to the railroad company in temporary track work. Also, operating conditions were improved since all railroad traffic was either on the high level or on the low level and not on both levels at the same time, and the time required for completing the work was considerably shortened. Street traffic benefited by the elimination of grade crossings six months earlier than would have been possible under the original scheme.

Sometimes the contractor, at his own expense, prefers to make a change in the track detours, thereby realizing a considerable saving himself and turning a complicated job into a simple one.

EQUIPMENT SELECTED FOR EACH JOB

No general method can be laid down for grade separation work. Each railroad and each contractor has different methods, and each job must be considered by itself. The major items of the work are usually concrete, steel, and fill or excavation. The plant for a particular job should be such as will fit the conditions found rather than whatever the contractor may have on hand, if the job is of any magnitude. The layout of the concreting plant depends somewhat on the source of the aggregates and the distance over which the work is spread. Central mixing plants, traveling mixers with towers, and ready-mixed concrete have all been used with good results. Fill can be made by either truck or rail haul, and again the nature of the job and the source of the material should be the governing considerations.

One of the major items of expense in such jobs is that due to working alongside, over, and under operating



NORMAL CONSTRUCTION DIFFICULTIES INCREASED BY PROXIMITY OF TRANSMISSION LINES AND THIRD RAIL

tracks. The safety of railroad traffic cannot be neglected for a moment, and the workmen must be protected against the hazard of passing trains by flagmen and warning signals. The results are that the efficiency of the men is lowered and expense is increased. Where retaining walls are constructed along an operating track with narrow clearance, the building and bracing of forms constitute quite a problem and add considerably to the cost per square foot. In many cases access for pouring concrete can only be obtained at the end of a wall. In other cases, a wall may be so close to adjacent buildings that the removal of forms is very difficult, or even impossible. I recall several instances where walls were required against adjacent buildings, making it difficult to put up bracing.

WORK IN CONFINED RIGHTS OF WAY

In Paterson, N.J., a grade separation for the two tracks of the Erie Railroad had to be built in very close quarters. It was only possible to retain one track in operation, as the foundation for the retaining walls occupied much of the available area. As shown in the accompanying series of photographs, after the first retaining wall was built there was not room to replace the track on the ground and therefore it was immediately placed in its final position on a trestle supported in notches left in the back of the retaining wall. The forms for the front of the retaining walls had to be built against adjacent buildings, so that it was impossible to use any bracing whatever on that side.

If the railroad is electrified, the hazard introduced by rail traffic is increased by the presence of the third rail, which must be treated with respect at all times. In one case, a sheet-metal worker desired to cut off one end of a long piece of corrugated iron. The track, which was near him, made an ideal anvil in his opinion. He placed his sheet across the rails and started cutting. As he was moving the piece to a more convenient position, the other end of it came in contact with the third rail. He was not hurt but he never knew what became of his piece of iron. Of course he had no business to be on the track, but it is impossible to have a watchman for every workman, and some men simply will not follow safety instructions when they think they know so much better themselves.

Wind Bracing in Steel Buildings

Structural Division's Subcommittee No. 31 Renders Its Third Progress Report

CONSIDERABLE discussion has been received by the Subcommittee on Wind Bracing in Steel Buildings since the publication of its Second Progress Report in the February 1932 issue of PROCEEDINGS. *Attention has been drawn to new aspects of the problem and additions have been made to the knowledge of the subject, so that a more accurate and workable method of design is in prospect, as evidenced by the Subcommittee's Third Progress Report, presented on January 19, 1933, at the Annual Meeting of the Society. The conclusions contained in the third report are summarized in the abstract that follows. The body of the report (37 typewritten pages and 2 figures) consists of three parts: (1) comments on the discussion of the Second Progress Report, (2) wind bracing design, and (3) rigidity of riveted and welded wind connections. An appendix (21 pages and 7 figures) amplifies and supports Part 2. The complete report may be consulted at Society Headquarters.*

THE conclusions reached by the Subcommittee on Wind Bracing in Steel Buildings may be summarized as follows:

1. Whatever prescribed wind force is finally adopted must be based not only upon recorded wind velocities at observation stations but also upon the modifying influences of shielding and turbulence and the general conditions set up for proportioning the frame and its details. It continues to be the belief of the Subcommittee that these modifying influences and conditions make the wind force tentatively recommended in the First Progress Report [CIVIL ENGINEERING for March 1931, page 481], that is, 20 lb per sq ft for the first 500 ft, increased above that level at the rate of 2 lb per sq ft for each 100 ft of height, generally adequate for the United States and Canada.

2. Considering the relative probability of the occurrence of full specified wind load and the simultaneous occurrence of full specified wind load and full specified live load, it is believed that the ratios of permissible stresses recommended in the Second Progress Report [PROCEEDINGS for February 1932, page 213] for members carrying various percentages of their total stress in the form of wind are satisfactory. Under any reasonable wind overload, the factor of safety would be approximately the same for members carrying a large percentage of wind as for those carrying a small percentage.

3. The use of higher permissible stresses for rivets and bolts is believed to be justified by the fact that there is a greater real factor of safety for these parts than for members subjected to compressive buckling.

4. A factor of safety of 1.5 for stability is believed to be adequate in that the resistance is based on gravity and not on the resistance of materials which may vary in strength, and since the probability of zero live load existing with maximum wind load is very small.

5. The stiffness factors for members permanently encased with concrete, and to which it is thoroughly bonded, should be calculated with proper allowance for the effect of the encasement. So far as wind distribution and resistance are concerned, reliance should not be placed upon floor construction, light or heavy, unless analysis shows it to be adequate for the duty.

6. Allocation of wind load to braced bents should take into consideration the eccentricity of the total lateral load to the lines of resistance.

7. Vibrational characteristics of buildings and the relation of sensation thereto must be determined experimentally before buildings can with certainty be designed to yield a desired degree of comfort to the occupants.

8. The Cross method of analysis is satisfactory for shallow bracing systems in buildings of moderate height in which the frame has been previously proportioned so as to maintain the floors substantially plane. It may, however, become unwieldy for tall structures, particularly if the design has not been prepared with a view to holding the joints at any floor of a bent in a straight line. Even in cases where the design has been so made as to render it unnecessary to compute the actual vertical translation of joints, it is desirable to isolate stories and apply the Cross method to them individually, adding to the direct stresses in the columns the stresses in the columns immediately above.

9. The portal method of design may, if care is exercised in proportioning, be used with satisfaction for buildings of moderate heights and proportions. When the beam spans are equal and the beam stiffness factors are also equal, the method is accurate except for (*a*) the effect of column bending as a factor in web distortion and (*b*) the effect of change of length of the columns under axial wind loads.

10. The cantilever method is generally more suitable for high frames than is the portal method. With equal beam spans and equal beam stiffness factors, the method is accurate except for (*a*) the effect of column bending as a factor in web distortion, and (*b*) the effect of unequal drift from beam bending under the assumed shear distribution.

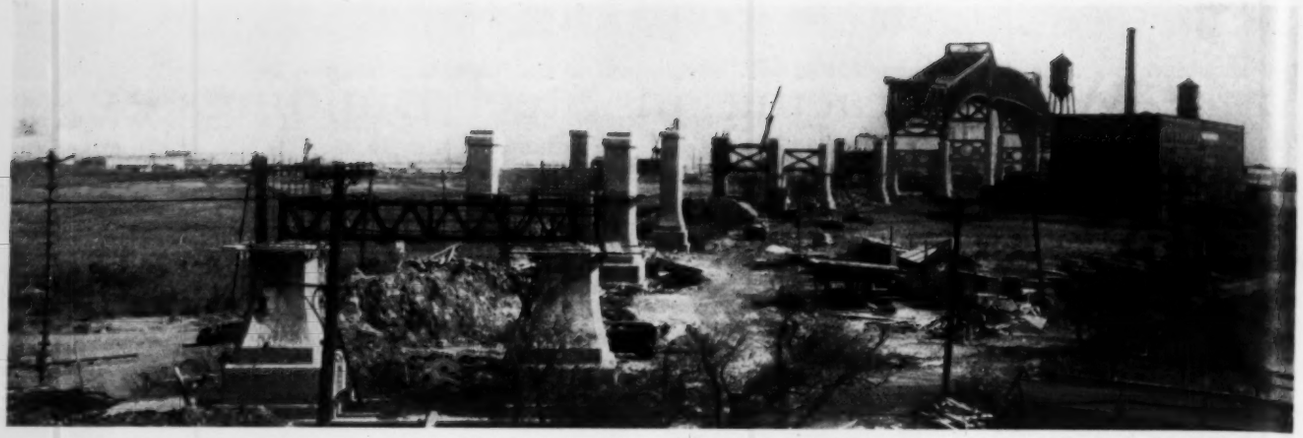
11. Spurr's method offers a simple means of proportioning a frame to ensure that the floor joints will remain in a straight line. Analysis of a frame so proportioned is greatly facilitated by reason of the negligible influence of vertical translation of the joints. The method is based upon the assumption that the web system in every panel may be made rigid enough to transfer to the columns, at design stresses, the vertical increments of wind stress that should be delivered to them if the bent is to act as a simple cantilever.

12. Experimental evidence indicates that typical welded wind connections are stiffer than typical riveted T's for the same orientation of the columns. Welded connections may, by reason of the flange reinforcement effect, give a stiffer bay than exists with an ideally connected beam of uniform moment of inertia.

Respectfully submitted,

C. R. YOUNG, *Chairman*
Clyde T. Morris
N. A. Richards
Francis P. Witmer

January 6, 1933



TYPICAL PIER CONSTRUCTION ON ELEVATED HIGHWAY NOW COMPLETED ACROSS HACKENSACK MEADOWS, NEW JERSEY

The New Jersey High-Level Viaduct

By H. W. HUDSON

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ENGINEER IN CHARGE, NEW JERSEY STATE HIGHWAY COMMISSION, JERSEY CITY, N.J.

WHEN the Holland Tunnel under the Hudson River was being constructed in 1923, the New Jersey State Highway officials foresaw the volume of traffic that would be attracted to it for entrance and exit to Manhattan Island. These officials visualized the difficulties this traffic would encounter in weaving its way along the then existing highways through the cities of Newark and Jersey City and the delays it would suffer due to open drawbridges over the intervening rivers. They therefore determined to provide an uninterrupted super-highway from the tunnel entrance through these cities. Economic studies based on the requirements of the War Department for the crossing of the Hackensack and Passaic rivers resulted in the design and erection of a 3-mile steel viaduct cutting diagonally across the Hackensack Meadows and passing 135 ft above the rivers. In this article, originally presented on January 19, 1933, before the joint session of the Construction and Structural Divisions at the Annual Meeting of the Society, Colonel Hudson explains the general design and describes many of the structural details.

WITH the opening to traffic on November 24, 1932, of the High-Level Viaduct on New Jersey's State Highway Route 25, the last link of that highway between Jersey City and a point west of New Brunswick, on the route to Trenton and Philadelphia, was completed. A brief review of events preceding the adoption of the high viaduct section extending for $3^{3}/_{4}$ miles between Jersey City and Newark, will explain the purpose of the structure.

In 1923, when the Holland Tunnel was under construction, William G. Sloan, M. Am. Soc. C.E., then State Highway Engineer of New Jersey, foresaw the necessity of a highway to provide free and uninterrupted travel through the metropolitan area of New Jersey, which includes Jersey City, Newark, and Elizabeth. He recommended the construction of such a highway to the State Highway Commission, which recognized that, with the opening of the Holland Tunnel, this would become the principal through route for traffic between New York and Pennsylvania, as well as for that to the South and West.

Originally it was planned to construct this section in such manner that the Hackensack and Passaic rivers would be crossed by movable bridges having a normal vertical clearance of 35 ft above mean high water. Since the two rivers are navigable and under the jurisdiction of the War Department, it was necessary to secure its permission for the crossings involved. The War Department permit required that the existing bridge on the Lincoln Highway, crossing the Hackensack River, should be removed following the completion of the new viaduct, so that there would be no increase in the number of movable bridges over the waterway. To have complied with the terms of the permit would have left traffic on the present Lincoln Highway without means for crossing the river.

FIXED SPAN HIGH-LEVEL BRIDGE ADOPTED

This requirement provoked considerable opposition from the industries located in South Kearny, as well as other affected interests, with the result that the commission was obliged to consider the replacement of the structure with a tunnel, which would have considerably increased the cost of the undertaking. In consequence, a new economic study was made on the basis of providing fixed-span bridges for both rivers at such height that all classes of navigation could pass under them. This study involved the cost of construction, maintenance, and depreciation, as well as that of vehicle operation—the latter including the items of distance, rise and fall, and delays. The results obtained indicated that the most economical type of structure would be a high-level fixed bridge. This type of construction was then adopted and a permit was obtained from the War Department for the two crossings to provide a clearance of 135 ft above mean high water. The second permit voided the previous requirement that the Hackensack Bridge on the Lincoln Highway should be removed.

DETERMINING THE ALIGNMENT AND PROFILE

The alignment of the highway for this section was changed from that contemplated when movable bridges were considered, to practically a straight line. The adopted alignment crosses the Hackensack River at an angle of about 45 deg. In accordance with the War

Department ruling that no bridge supports should be constructed within the channel, which is 300 ft wide, a river span of 550 ft was required. As the Passaic River is crossed at right angles, it was found practicable to duplicate the Hackensack River structure there.

After the type of structure for the two crossings had been determined, the connecting viaduct was made to conform with the general outline of the river spans, consideration being given to the distance between the rivers and to the necessity of providing connections to and from the surface highways. It would have been practicable to lower the viaduct level on each side of the river crossings so that it would just clear the existing streets, but it was found that any saving in construction which might be effected by such a profile would be overbalanced by the additional cost of vehicle operation due to the rise and fall in elevation. It was therefore decided to provide gradients that would result in a reasonable length of ramp for the surface street connections. The elevation of the depression in the profile was made such that the maximum gradient to reach the established height of the river structures would be $3\frac{1}{2}$ per cent.

An economic study of span lengths indicated that long spans should be used. Not only did the high elevation of the roadway and the great depth to suitable foundations make long spans economical, but also numerous piers would be definitely objectionable because the greater part of the area under, and adjacent to, the viaduct will ultimately be used by industries requiring railroad facilities. Estimates of costs for substructure and superstructure showed that the most economical length for the spans between the river crossings would be about 300 ft, and this length was therefore adopted. However, because of existing streets and railroad tracks, it was not practicable to secure uniform spacing between piers, but their locations were so selected as to make the span lengths as uniform as possible.

BOTH PILES AND CAISSONS USED FOR FOUNDATIONS

Between the Hackensack and Passaic rivers, and for some distance west of the latter, the material underlying the surface is swamp mud with a mixture of clay and sand below. The depths of these materials and their consistency made it unwise to use pile supports for the foundations, and therefore concrete caissons extending to rock were employed. The deepest caisson, located about midway between the two rivers, extends 141 ft below mean high water. The highest point at which rock was encountered was in the Hackensack River, at a depth of approximately 25 ft.

Wells were provided in each caisson for sinking by open dredging. This method was followed until hardpan was encountered, when compressed air was used for founding and sealing the caissons on the rock. One contractor constructed his caissons by removing the forms as the sinking progressed, while another elected to leave the forms in place. Roofs for air locks were built in the dredging wells at convenient elevations. After the caissons were founded, the wells were filled with concrete.

At and between the two river crossings, single caissons were used for each pier. West of the Passaic River, each pier was supported on two caissons, since the length of the spans, their reactions, and the depth to rock indicated this to be the most economical method. In this case, the two caissons for each pier were tied together by a reinforced concrete mat. Where one caisson was used, the two pier shafts were supported directly on the caisson, but where two caissons were used, both shafts are supported on the mat. Where the height of the piers was such as to require ties between the shafts, structural steel stiffening trusses were employed. These were subsequently encased in concrete so as to give the appearance of masonry rather than of steel covered with concrete.

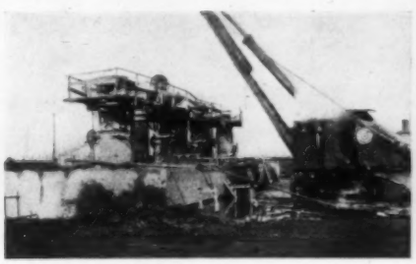
Borings east of the Hackensack River indicated the presence below the swamp mud of layers of clay and sand of varying densities and thicknesses, which it was decided would provide a satisfactory support for pile foundations. Since in that section the height of the viaduct was not excessive and satisfactory foundation conditions were found at no great depth, the economic span length was determined to be approximately 200 ft. All the foundations between the Pennsylvania Railroad crossing and the easterly side of the Hackensack River were therefore constructed on concrete piles. For the greater part of this section, where the depth of the swamp mud is about 10 ft, all the concrete footings extend to approximately this level, the piles being supported throughout their length in clay and sand.

DESIGN OF THE SUPERSTRUCTURE

The superstructure between the Pennsylvania Railroad crossing in Jersey City and the westerly end of the viaduct in Newark, is of the cantilever type. It was found uneconomical to encase the steel in concrete or gunite on account of the additional weight that would have to be supported by the foundations. Between the Hudson County Boulevard and the Pennsylvania Railroad crossing—with the exception of the through-truss spans over the Erie Railroad and two deck-truss spans over Jersey City streets—deck plate girders supported on steel columns, encased in concrete and gunite, were used. The cantilever type was selected after preliminary designs and estimates of cost had been made for various types of construction. Except at the river crossings, a deck-type structure was used throughout because of economy. Alternate spans are of the fixed type, the intervening spans being of the cantilever and suspended-span type.

The structure is designed for H-20 loading, as prescribed in the specifications of the American Society of State Highway Officials. With load stresses as high as 24,000 lb per sq in., it is evident that careful computa-

BUILDING CONCRETE CAISSONS FOR PIER NO. 90



AIR LOCKS IN USE FOR FOUNDING AND SEALING CAISSON NO. 71 ON ROCK

WELDED TRUSS REINFORCING IN THE ROADWAY SLABS

tion of all stresses, including secondary, was necessary. Further computations of the camber in each truss were also required to ensure the proper shape when loaded. This was particularly important where the structure is widened to provide for ramp connections. At these points it was found necessary to support the roadway on three and sometimes four trusses, each of which in many cases carries different loads.

At the river crossings, the War Department permit required a vertical clearance of 135 ft within the established channel width. In order that the roadway might not be any higher than necessary, through instead of deck truss construction was used. It was decided, for appearance sake, to digress from the orthodox type of cantilever construction by designing the anchor arm spans to change gradually from the through to the deck type of construction. To accomplish this involved complicated features, but it is hoped that the resulting effect warranted the additional effort.

To provide connections between the viaduct and the surface streets, ramps were constructed at various locations. These ramps are generally in the center of the roadway and are wide enough to provide for one line of traffic in each direction. Where they are so placed, the main roadway is divided into two parts, each 30 ft wide. In some instances, where conditions do not permit the use of center ramps, side ramps were constructed, one for entrance and the other for exit, each ramp being made wide enough for two lines of traffic.

Primary floor beams are provided at each panel point of the trusses, which in general are spaced 25 ft on centers. These beams support stringers spaced about 8 ft on centers, on top of which are secondary floor beams running transversely across the viaduct. These secondary beams are spaced close together at the center and near the ends of the stringers in order that the moments in the deck slab will be as uniform as possible. The slab, which also forms the roadway surface, is $8^1/_2$ in. deep and is reinforced by welded trusses made up of round reinforcing bars. Both chords of the trusses consist of two bars welded to each side of the web member, the welding being accomplished by the arc pressure method. As the secondary floor beams were placed transversely, the floor slab trusses were laid at right angles, or lengthwise, in order to attain a better distribution of the live load. Transverse distribution bars were used at the top and bottom of the trusses and extend across the width of the roadway. Rectangular bearing bars support the reinforcing trusses at each floor beam to ensure the placing of the trusses at the proper elevation in relation to the deck structure. The trusses were fabricated in units or mats 10 ft wide and in lengths corresponding to the spacing of the main floor beams. The mats were quite rigid but easy to handle in erection. They were field welded to the deck structure by attaching the bearing bars to the tops of the floor beams, thus forming an integral part of the floor system. The distribution bars, being continuous across the width of the roadway, were welded together at the ends of the mat sections to develop the full strength of the bars.

NEW JERSEY EXPRESS HIGHWAY ELIMINATES TRAFFIC DELAYS
135-Ft Clearance Over Passaic and Hackensack Rivers

ROADWAY PROVIDES FIVE TRAFFIC LANES

The concrete slab, constructed in strips 10 ft wide, is used as the roadway surface. Its top has been finished in the usual manner for this purpose. The width of the roadway is 50 ft between curbs, which normally provides for five lanes of traffic. It is not considered probable that all five lanes will be used as a general rule, but if a disabled vehicle should obstruct traffic on one lane, four lanes will remain open. The height of the curb was made 16 in. in order to minimize the possibility of a vehicle's mounting it in case of an accident. A continuous opening is provided along the curb so that rain, snow, and dirt can be readily removed from the roadway. On each side there is an emergency footwalk 2 ft wide. It is constructed of a plate girder laid flat and secured to the floor beams and is designed to resist the impact of any vehicle that may strike the curb.

In order to give the users of the highway an adequate sense of safety, the railing selected was of an unusually heavy type. It was constructed of 6-in. I-beams, spaced 12 in. on centers, with a top rail of built-up channels and shapes.

Lighting is provided by 600-cp incandescent lights, suspended from brackets attached to structural steel posts spaced 150 ft apart and staggered on each side of the structure. These lights, which are 23 ft above the roadway, are of the refractor type. They give an even distribution of light over the roadway surface and at the same time prevent an undue loss of light over the sides of the viaduct. The lighting system is so arranged that if one series gets out of order the alternate series will continue to function. The bridges across the Hackensack and Passaic rivers are equipped with aviation beacons mounted on top of each of the two towers of each bridge. Navigation lights, indicating the limits as well as the centers of the channels, have been installed on each of the channel spans.

Traffic on the viaduct on Sunday, November 27, 1932, the third day following its opening, exceeded 5,400 vehicles for a one-hour period. The average for the first seven days following the opening was more than 36,000 vehicles a day. This, however, does not indicate the average volume of traffic at the present time as a large number of the vehicles observed during that week were evidently on a sight-seeing trip. The estimated annual capacity of the viaduct is 20,000,000 vehicles, whereas it has been found that present traffic is at the rate of about 10,500,000 per year.

Cost of Traffic Delays

Another Phase of the Problem of Highway Economics

By S. Johannesson
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ELIMINATION of delays to traffic has frequently been given as the main reason for the construction of costly highway improvements such as traffic circles and grade separations. When construction of this type is under consideration, engineers and others may often feel doubt as to whether the proposed outlay is justifiable, and this question can only be answered by computing the cost of the delays to be eliminated. But in the past little attention has been paid to methods of computing this factor. In the paper read before the Highway Division on January 19, 1933, at the Society's Annual Meeting, and here abstracted, Mr. Johannesson presented a most interesting procedure for determining just what delays to motor vehicles actually cost in terms of money.

SINCE the study of highway economics is quite new, it is natural that there should be a number of questions relating to it that have not been fully answered as yet. One of the problems, about which considerable uncertainty exists, is the cost of traffic delays, a matter that has a direct bearing on the economic justification of a large number of highway improvements.

A delay, as understood in this article, occurs whenever an interference on the road causes a reduction of the standard rate of speed, that is, the rate of speed at which the driver desires to travel, which must be, of course, within the legal limit and within the capacity of the vehicle. The delay is measured by the traveling time actually used less that which would have been required if a standard rate of speed had been possible. A vehicle on the road has a driver and possibly other occupants. When it is delayed, therefore, the cost of the delay includes not only the monetary value of the vehicle minute as applied to the vehicle, but also the value of the time of the occupants. The former will be considered first.

MONEY VALUE OF TIME OF DIFFERENT TYPES OF VEHICLES CALCULATED

It is conceivable that the time value of a vehicle might be greater than the cost of operation, but it cannot be considered to be less. The cost of operation may be determined by adding together the various items of operation cost that apply whether or not the vehicle is in motion. These may be called the time items and include the following: (1) interest on capital invested, (2) insurance, (3) license fees, (4) garage rent, (5) taxes, (6) depreciation (in part), and (7) supervision and overhead.

Consider first the case of a passenger automobile costing $900, and assume its life to be six years. The average interest on the capital invested, at 6 per cent per annum, less depreciation, will be $31.50. Insurance including that for fire, theft, public liability, and other protection, may be taken to amount to $50 per annum. License fees may average $13.50 and garage rent $48 each year. Where property taxes are collected, there may be a charge of $5 under taxes. A motor vehicle depreciates when it is being operated, but also, although to a less extent, when it is standing still. It is assumed here that one-third of the depreciation is chargeable to the time items, making the annual charge $50. Under the head of supervision and overhead, there will usually be no charge for passenger automobiles used either for private or commercial purposes.

The total annual charge against time items for passenger automobiles may then be summed up in the following tabulation:

Interest	$31.50
Insurance	50.00
License	13.50
Garage	48.00
Taxes	5.00
Depreciation	50.00
Supervision and overhead	0.00
Total	$198.00

As for passenger cars used for commercial purposes, it may be assumed that they are in service 44 hr a week, or excluding holidays, 2,240 hr a year, and that all cost charges against them must be distributed over these hours. The charge per hour is then $19{,}800 \div 2{,}240 = 8.84$ cents, or about 0.15 cents per minute. For passenger cars used for private purposes, which cannot be limited to any definite working hours, it may be proper to distribute the charge over 24 hr per day throughout the year, in which case the charge per minute will be about 0.03 cent. For trucks and buses it may be assumed that the original cost of the vehicle is $1,200 and

Crossing of the Passaic River Between Newark and Jersey City, N.J.
Traffic on the Lincoln Highway Held Up by a Single Empty Barge

that its life is three years. The annual charges against the time items will then be about as follows:

Interest	$48.00
Insurance	120.00
License	30.00
Garage	48.00
Taxes	6.00
Depreciation	133.00
Supervision and overhead	77.00
Total	$462.00

If the vehicle is in service 2,240 hr a year, the charge will be 46,200 ÷ 2,240 = 20.6 cents per hr, or 0.34 cent per min, exclusive of the charge against the driver's time.

COST OF DELAYS IN TERMS OF VEHICLE OPERATION

Recapitulating, as far as the cost of operation of vehicles is concerned, the following values have been determined:

Trucks	0.34 cent per vehicle minute
Passenger cars used for commercial purposes	0.15 cent per vehicle minute
Passenger cars used for private purposes	0.03 cent per vehicle minute

A motor truck while on the road will have a driver, whose average wage may be taken at 60 cents per hr. To this should be added, say, 15 per cent to cover supervision and overhead, making the total cost 69 cents per hr, or 1.15 cents per min.

It is probable that the weekly salary of those who use passenger automobiles for commercial purposes will average about $30, or $1,560 per year. With 2,120 working hours per year, the rate will be 73.6 cents per hr, or 1.23 cents per min. For passenger cars used for private purposes, there should be added the time value of the occupants of the car, and it is this value that is difficult to establish.

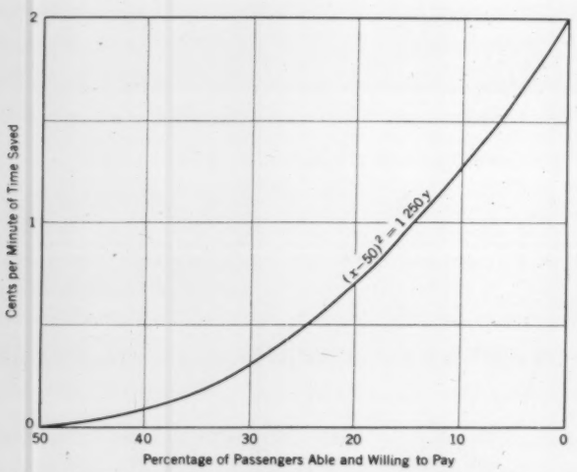


FIG. 1. WILLINGNESS AND ABILITY OF OCCUPANTS OF PRIVATE PASSENGER AUTOMOBILES TO PAY FOR TIME SAVED

PEOPLE WILL PAY FOR TIME SAVED

Where there is an opportunity to pay for the privilege of saving traveling time, many people will do it. For example, the railroads between New York and Chicago used to charge an extra fare on trains making the trip in less than the standard travel time. This extra fare amounted to $1.20 per hr, or 2 cents per min saved. A similar condition exists in water transportation. It is possible to select for the voyage between New York and Cherbourg a steamer that will make the trip in 8, 7, or 6 days. On all three steamers the accommodations and the service are practically alike, but a comparison of the rates of fare charged indicates that there is an extra cost amounting to about $30 for each day saved in traveling time. This corresponds to $1.25 per hour, or about 2 cents per min. In both these cases it is seen that some people actually pay at the rate of 2 cents per min for traveling time saved.

It is concluded that, while 50 per cent of the motoring public may not be willing or able to pay for the saving of time, the remaining 50 per cent are able and willing to do so, at a rate ranging from zero to 2 cents per min, according to the curve plotted in Fig. 1. This curve is a parabola following the equation:

$$(x - 50)^2 = 1{,}250\,y \quad \ldots\ldots\ldots\ldots [1]$$

If the willingness and ability to pay follow this curve, then the average money value of a minute saved would be one-third of a cent per person. Assuming that the average number of occupants in privately operated cars is 2.25, then at the rate of $^1/_3$ cent per min per occupant, the total value of the time of the occupants will be 0.75 cent per vehicle minute. The total value of time for the various types of vehicles can then be tabulated as follows:

Trucks:		
Vehicle operation	0.34 cent	
Driver	1.15 cents	1.49 cents
Commercial passenger cars:		
Vehicle operation	0.15 cent	
Driver	1.23 cents	1.38 cents
Private passenger cars:		
Vehicle operation	0.03 cent	
Occupants	0.75 cent	0.78 cent

Of the total number of motor vehicles registered in the United States, about 13 per cent are trucks, and probably about 29 per cent are commercial passenger cars and 58 per cent private passenger cars. With this distribution, the average money value of a vehicle minute may be determined as follows:

		Per Cent Vehicle	Per Cent Driver
Trucks:			
Vehicle operation	0.34 × 0.13 = 0.0442 cent	4.22	
Driver	1.15 × 0.13 = 0.1495 cent		14.29
Commercial passenger cars:			
Vehicle operation	0.15 × 0.29 = 0.0435 cent	4.16	
Driver	1.23 × 0.29 = 0.3567 cent		34.09
Private passenger cars:			
Vehicle operation	0.03 × 0.58 = 0.0174 cent	1.66	
Occupants	0.75 × 0.58 = 0.4350 cent		41.58
Totals	1.0463 cents	10.04	89.96

This tabulation indicates that the average money value of a vehicle minute is a little more than 1 cent. It also indicates that only 10 per cent of this amount is due to vehicle operation proper, the remaining 90 per cent being the time value of the occupants of the vehicles.

If in some specific case the proportion of the various classes of vehicles or some of the other basic figures used, are materially different from those given here, some other money value must be assigned to the vehicle minute. For example, in the TRANSACTIONS of the Society, Vol. 95, page 1028, the money value of a vehicle minute is given as 2 cents, but this refers particularly to the time value of the traffic on New Jersey State Highway Route

25, leading from the Holland Tunnel through Jersey City and Newark to Elizabeth. On this highway the proportion of heavy trucks is exceptionally large, and for that reason the estimated money value of a vehicle minute naturally is materially greater than that for the average highway.

MEASURE OF VEHICLE MINUTES LOST BY DELAYS

Delays may be divided into two general types, those that involve the general slowing down of traffic and those that involve the stopping of traffic. The first type includes those caused by an insufficient number of traffic lanes, by parking on traffic lanes, by poor pavement, by insufficient sight distance, and by other similar conditions. The second type of delay covers mainly that caused by periodic interruptions to traffic due to crossing traffic on intersecting railways, waterways, or other highways.

For the first type of delay, the time lost may be measured by observing the time needed to pass through the zone in question and comparing it with the time that would be required to cover the distance at the standard rate of speed. The average difference between these two time periods, multiplied by the number of vehicles affected, will give the total time lost. For the second type of delays, the time lost can be measured in a similar manner, but the result may be more uncertain, because the delay to each individual vehicle will be considerably less uniform.

For this reason, I have developed the following equation, by means of which the total time lost may be determined when certain conditions are known:

$$T = \frac{a^2 p}{2\,(d - t)} \quad \ldots\ldots\ldots\ldots [2]$$

in which T = total time lost, expressed in vehicle minutes

p = standard rate of speed in feet per minute

a = time period of stoppage of traffic, in minutes

d = average distance from center to center of vehicles, when running at a standard rate of speed, in feet

t = minimum distance from center to center of vehicles, in feet

The distance t in the equation is the spacing between vehicles at maximum density, which varies with the rate of speed at which the vehicles are moving. Very little information appears to be available as to the minimum safe spacing of vehicles at various rates of speed, but from such meager records as exist, I have tentatively concluded that the spacing t, expressed in feet, may be determined by the equation:

$$t = 0.025\,q + 25 \quad \ldots\ldots\ldots\ldots [3]$$

where q is the rate of speed in feet per minute at which the vehicles are moving.

There exists, however, some difference of opinion as to the correctness of this expression and this difference may be shown by considering three equations that have been developed to show the number of vehicles that can be passed over a road at various speeds. First, from Equation 3:

$$N = \frac{5{,}280\ V}{2.2\ V + 25} \quad \ldots\ldots\ldots\ldots [4]$$

where N is the number of vehicles that can pass a given point in 1 hr, and V is the velocity in miles per hour. The second, a tentative equation for maximum density, presented by A. N. Johnson, M. Am. Soc. C.E., was published in TRANSACTIONS, Vol. 89, page 264. This equation reads as follows:

$$N = \frac{5{,}280\ V}{15 + \frac{V^2}{15}} \quad \ldots\ldots\ldots\ldots [5]$$

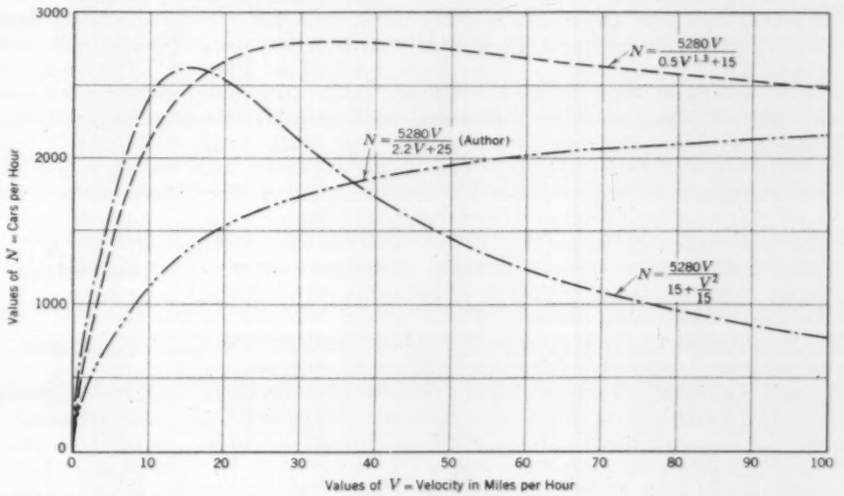


FIG. 2. GRAPHIC COMPARISON OF FORMULAS FOR DETERMINING THE RELATION BETWEEN THE NUMBER OF VEHICLES PASSING A GIVEN POINT AND THEIR RATE OF SPEED

In the *Proceedings* of the Eighth Annual Meeting of the Highway Research Board, 1928, page 114, Mr. Johnson revised this equation to read:

$$N = \frac{5{,}280\ V}{0.5\ V^{1.3} + 15} \quad \ldots\ldots\ldots\ldots [6]$$

The curves representing these three equations, reduced to the same units, are shown in Fig. 2. It is apparent that there are material discrepancies in the results obtained. The reason is probably that, as yet, there is insufficient information available to make a close determination of the relation of vehicle spacing to rate of speed.

ECONOMIC JUSTIFICATION FOR HIGHWAY IMPROVEMENTS

As previously stated, the cost of a delay is determined by the money value of a vehicle minute and the number of vehicles minutes lost by the delay. When these two factors have been established, the cost is arrived at by simple multiplication. The cost of the highway improvement necessary to avoid delays may be found by standard engineering methods, and a comparison between this amount and the estimated cost of delays will indicate whether or not the improvement is economically justified, unless there are other tangible or intangible benefits gained by the improvement. Generally speaking, an improvement is not economically justified unless its estimated cost is materially less than the estimated cost of the delays eliminated.

Society Committees Report

At the Annual Meeting in January 1933, several research committees of the Society rendered an account of their work during the preceding year.

COMMITTEE ON CONCRETE AND REINFORCED CONCRETE ARCHES

THE COMMITTEE on Concrete and Reinforced Concrete Arches was appointed in May 1923, and has presented reports of progress at each Annual Meeting since that date. These reports have been printed in PROCEEDINGS from time to time. Shortly after the committee was organized, consideration was given to the question of having extensive experimental work done at the University of Illinois. The university indicated its willingness to have Wilbur M. Wilson, M. Am. Soc. C.E., Research Professor of Structural Engineering, spend a considerable portion of his time on this work, provided that the reports of these investigations were to be available for publication as bulletins of the Engineering Experiment Station.

Four bulletins have been published by the University of Illinois, describing experimental work on arches, which was financed in part by the Society and the Engineering Foundation, in part by the university, and for the past two years, in part by the U.S. Bureau of Public Roads. These bulletins are:

No. 174. Effect of Climatic Changes Upon a Multiple Span Reinforced Concrete Arch Bridge
No. 202. Laboratory Tests of Reinforced Concrete Arch Ribs
No. 226. Laboratory Tests of Reinforced Concrete Arches with Decks
No. 234. Movements of Piers During Construction of Multiple Span Reinforced Concrete Arch Bridges

When the cooperation of the U.S. Bureau of Public Roads was secured, the testing program outlined was as follows:

1. Single span; rib without deck.
2. Three-span system; rib without deck; pier heights 10 ft, 15 ft, and 20 ft.
3. Three-span system; rib with low deck; expansion joints at piers only; three pier heights as in No. 2.
4. Three-span system; rib with low deck; expansion joints at piers and near the third points of each span; three pier heights.
5. Three-span system; same as No. 3 with high deck.
6. Three-span system; same as No. 4 with high deck.
7. Single span; rib with low deck having no expansion joints.
8. Single span; rib with low deck having expansion joints near third points.
9. Single span; rib with high deck having no expansion joints.
10. Single span; rib with high deck having expansion joints near third points.

Of these 10 structures, the tests are complete and the reports printed on Nos. 1, 2, 7, 8, 9, and 10; No. 5 has just been completed; and No. 6 is now ready for test. It is hoped to complete Nos. 3 and 4 by September.

The present tests are being made on systems of three arch spans, each 27 ft long, with a rise of 6 ft 9 in., supported on piers 10 ft, 15 ft, and 20 ft in height. This makes the over-all length of the structures nearly 100 ft.

Each of the above structures is being tested for deformation and influence lines, care being taken to avoid excessive cracking of the concrete. Each structure will be loaded to destruction with a pier height of 20 ft.

Supplementing the work at the University of Illinois, two fellowships were established for the year 1931–1932 at the Ohio State University. One was financed by the U.S. Bureau of Public Roads and the other by the Ohio State University. The two Fellows made theoretical or model analyses of items 1, 2, 3, 4, 7, 8, 9, and 10 of the structures being tested at the University of Illinois. Similar analyses were made for the committee of items 1, 5, 6, 7, 8, 9, and 10 by two graduate students at the Case School of Applied Science, under the direction of Fred L. Plummer, M. Am. Soc. C.E., Assistant Professor of Civil Engineering. The results of these theoretical and model analyses are for comparison with the results of the tests at the University of Illinois.

The committee believes that any Society members who find it convenient to observe the testing procedure at Urbana, Ill., will do so with both interest and profit.

Respectfully submitted,

CLYDE T. MORRIS, *Chairman*
G. E. Beggs A. C. Janni
E. H. Harder W. M. Wilson

January 18, 1933

COMMITTEE ON EARTHS AND FOUNDATIONS

THE COMMITTEE on Earths and Foundations, of which Lazarus White, M. Am. Soc. C.E., is chairman, after two years of research work submitted a written report. It will present to engineers recent theories of soil mechanics, particularly that of the compressibility of thick layers of saturated soil. The theory has been applied to an existing building erected 20 years ago, and the theoretical settlements and their rate agree closely with those observed on the building itself. This and the results of other studies by the committee are expected to be available in an early issue of PROCEEDINGS.

COMMITTEE ON IRRIGATION HYDRAULICS

THE COMMITTEE on Irrigation Hydraulics has been in existence for ten years, under the continuous chairmanship of D. C. Henny, M. Am. Soc. C.E. During this time its members have done an imposing amount of work. It has kept before it ten major subjects for study, each as pertinent to water supply, power, and other hydraulic subjects as it is to irrigation. The subjects mentioned in the report include a glossary of hydraulic terms and symbols; evaporation from soil and other surfaces; water pressure under dams; siphon spillways; silt and silting; scouring below dams; the Parshall measuring flume; lateral flow spillways; permissible canal velocities; and fishways.

COMMITTEE ON METEOROLOGICAL DATA

THE FIRST REPORT of the Special Committee on Meteorological Data, under the chairmanship of Donald M. Baker, M. Am. Soc. C.E., was presented at the Annual Meeting of the Society and is to be found in the January 1933 issue of PROCEEDINGS.

COMMITTEE ON STEEL COLUMN RESEARCH

HEADED by F. E. Turneaure, M. Am. Soc. C.E., the Committee on Steel Column Research rendered its final report after nine years of service. It is planned to publish this masterly research report in the 1933 volume of TRANSACTIONS. Full-size columns of various designs were tested (75 or 80) with definitely known end conditions. The general conclusion from these tests

was that the ultimate strength of columns can be calculated from theoretical formulas within 5 or 10 per cent, when the value of the yield point of the material in the column is used in the proper formula.

COMMITTEE ON STRESSES IN RAILROAD TRACK

CHAIRMAN A. N. Talbot, Hon. M. Am. Soc. C.E., of the Committee on Stresses in Railroad Track, has again rendered a progress report of the work of his committee. Its study has been in progress continuously since 1913, and a large number of progress reports have already appeared in PROCEEDINGS and TRANSACTIONS. The results obtained have been largely instrumental in the modification of locomotive balancing, and the design of rails and track fastenings, bridges and track structures. This committee has worked jointly with a similar committee of the American Railway Engineering Association and has also cooperated with the American Railway Association. Presumably the progress report of the past year's work will be published by the former organization in its bulletin.

COMMITTEE ON FILTERING MATERIALS

THE ACTIVITIES of the committee of the Sanitary Engineering Division on Filtering Materials for Water and Sewage Works have been confined during the past year principally to the operation of experimental water filters with reference to the effect of sand size when filtering different types of water. Some thought has been given to certain features of the sodium sulfate test for soundness of trickling filter media. No meeting of the committee has been held during the year.

Two tentative reports of the committee were presented at the October 1931 meeting in St. Paul, one relating to the selection, testing, and preparation of filter material for sewage trickling filters and the other relating to fine-grained filter materials for sewage filters. It was expected that these reports would serve as the basis of Manuals of Engineering Practice on the two subjects. However, owing to financial conditions, no effort has been made to publish the reports and they have remained in the hands of the committee.

During the last 18 months further development has occurred in engineering knowledge, particularly as regards the sodium sulfate soundness test and the operation of trickling filters with different types of media. The American Society for Testing Materials has issued a tentative standard procedure for a sodium sulfate test, and a number of testing material laboratories have tried out both the procedure proposed by this committee and that of the American Society for Testing Materials. So there is further information from which to judge the soundness test procedure.

A rather extended series of experimental filter data for four different types of filter media have been made public by the New Jersey Experimental Station. A full scale experimental filter 120 ft in diameter, with four segments, each filled with a different variety of filter material, has been put in operation at Peoria, Ill. No analytical results are yet available for the operation of this filter.

At the St. Paul Meeting, this committee stated that the relative importance of the trickling filter as a sewage treatment element warrants a more definite attempt to determine the relative importance of the many factors which control the efficiency of operation. Such efforts will require a collection and analysis of data and the coordination of the energies of numerous investigators, probably extending over some considerable period of time. A committee of this division would be the proper agency for such work. Nothing has occurred to change this conclusion.

Quite active interest has been displayed in the investigation of water filter sands being conducted under the direction of James W. Armstrong, M. Am. Soc. C.E., a member of the committee. Filtration departments in upwards of 14 cities have interested themselves in this study to the extent of installing a series of experimental glass tube filters at their own expense.

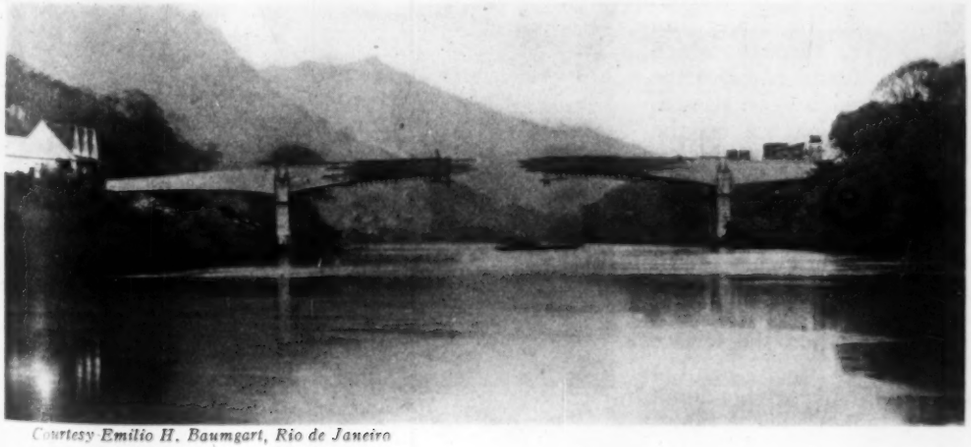
Some of the cooperating cities have been quite active and have developed considerable data. Others have been interested, but have been delayed in getting actively under way. The progress of the investigation has undoubtedly been retarded somewhat by the depression. It is anticipated that sufficient data can be got together and analyzed within the next several months to enable the formulation of a definite conclusion with reference to the value of these experiments. Meanwhile, it is hoped that the program of investigations can be continued so that operating data will be available from a number of localities for at least a 12-month period.

Respectfully submitted,

WILLIAM E. STANLEY, *Chairman*

James W. Armstrong — George B. Gascoigne
W. H. Dittoe — N. T. Veatch, Jr.

January 18, 1933



Courtesy Emilio H. Baumgart, Rio de Janeiro

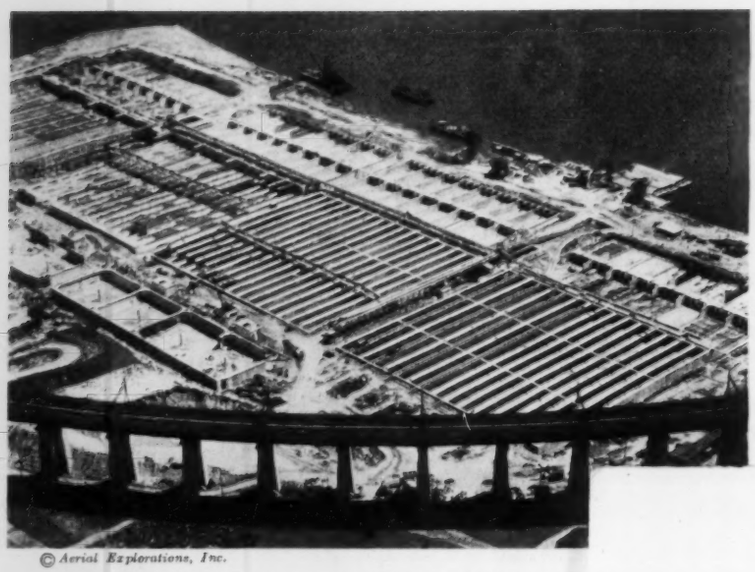
REINFORCED CONCRETE BRIDGE
Cantilever Construction of a 224-Ft Span Over a Brazilian River

Construction of Ward ment Work

By Richard H. Goul

Engineer of Sewage Disposal and Intercept

ONE of the inspection trips arranged for visiting members during the Annual Meeting had as its objective New York City's activated sludge sewage treatment plant now under construction on Wards Island in the East River, opposite 110th Street. Since ground was broken in June 1931, rapid



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Distribution of Concrete by Long Lines of Belt from a Central Mixing Plant

IN 1927 the New York State Legislature turned to the City of New York about 52 acres of lan Wards Island for the site of a sewage treatr works. In 1 following pre nary report contract was r with Fuller McClintock, I neers, for the plete design plant of the vated sludge with a capaci 180 mgd. A same time, liminary plan intercepting

Reinforced Concrete Venturi Meter 72 by 40 In., on the Influent Line

ers were started in the offices of the borough presic of Manhattan and the Bronx. Since the formatic the Department of Sanitation on December 1, 1929 entire project has been under its jurisdiction.

The Wards Island project has been previously scribed in Civil Engineering for November 1931, will be but briefly reviewed here. The plant will receive the drainage to the Harlem River and part of that to the East River from both Manhattan and the Bronx. The general plan proposed consists of intercepting sewers constructed along the water front of Manhattan and the Bronx, bordering on the Harlem River and nearby sections of the East River, through which sewage and storm water up to the amount of twice the dry-weather flow of the tributary area will be passed. The sewers in the tributary area, which are on the combined system, lie at such an elevation along the water front that tide gates will be necessary to prevent the harbor water from flowing back into them. The interceptors will lead to a coarse screening and grit chamber in each borough for the removal of heavy grit and other material that might obstruct the tunnels and pumps. From the grit chambers, deep-lying tunnels in rock under the East River will conduct the sewage to the pumping station on Wards Island.

The pumps on Wards Island will lift the sewage about 45 ft to the preliminary settling tanks. These tanks, from the final settling tanks by sludge removers of the mechanical conveyor type. Discharge to the river is through two conduits ending at the bulkhead line.

Pouring Diffuser Plate Boxes in Aeration Tanks

TIGH

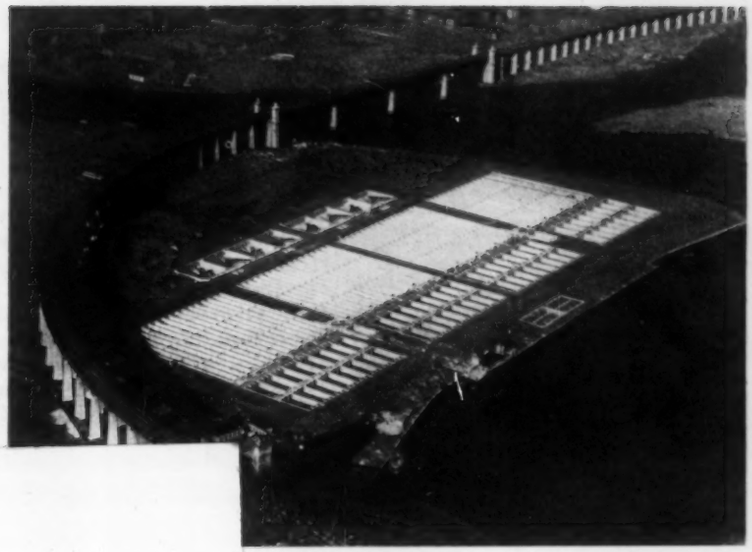
BOU

Island Sewage Treatment Ahead of Schedule

MEMBER AMERICAN SOCIETY OF CIVIL ENGINEERS

ENGINEERS, DEPARTMENT OF SANITATION, NEW YORK, N.Y.

...struction features which contributed to the unexpectedly rapid progress of the work. Belt conveyors, both fixed and portable, assisted in solving the problem of placing over 100,000 cu yd of concrete in forms spread over an area of 40 acres. The shifting ... movable forms on converted truck chassis and the



AERATORS, FINAL TANKS, AND DOCK COMPLETED
tograph Taken in January 1933

HTLY

UND

...ock and sea wall, and on Contract B, for the ... operating galleries. Work was authorized ... June 18, 1931, under Contract B, and on ...31, un... ...t A. ... A, for ...nd sea ...d out ...derick ...ration ...k, has ... com... ...ost of ...4,000. ...y with ...ments ...tarter,

Courtesy U.S. Pipe and Foundry Company
42-IN. METER IN INFLUENT LINE

...as carried out under the supervision of the ... of Docks, with F. T. O'Keefe as Chief Engi... ...illiam C. Crosby in immediate charge of con... The Department of Sanitation, however, ...neral control of the work.

...B includes the construction of the preliminary and final tanks, aeration tanks, operating gallery, substructures of the sludge pumping stations, foundations for the storage building, conduits, and piping. The work was awarded to W. H. Gahagan, Inc., of Brooklyn, for about $3,900,000. A subcontract for the concrete work was given to the Turner Construction Company. Subcontracts for the clarifying equipment in the preliminary tanks went to the Dorr Company, and that in the final tanks to the Link-Belt Company. This selection was based on the relative prices bid on carefully prepared alternate designs for both types of equipment.

It is interesting to note that the Gahagan Company's estimate was nearly $700,000 lower than the next bidder and about $2,300,000 below the early engineers' estimates, based on pre-depression prices. A time limit of four years was allowed, but the bulk of the work was finished in 18 months.

The work is now nearly complete, and indications are that its cost will be less than the sums shown on the bid sheets. The amount of extra work has been almost negligible. This is an indication of the completeness of

...piping sewers and treatment works would be about $30,000,000. At present prices, it is thought that this cost will be under $24,000,000.

In the spring of 1931, bids were received on Contract

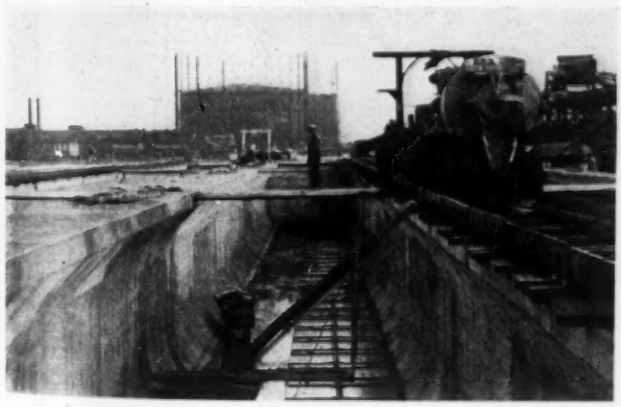
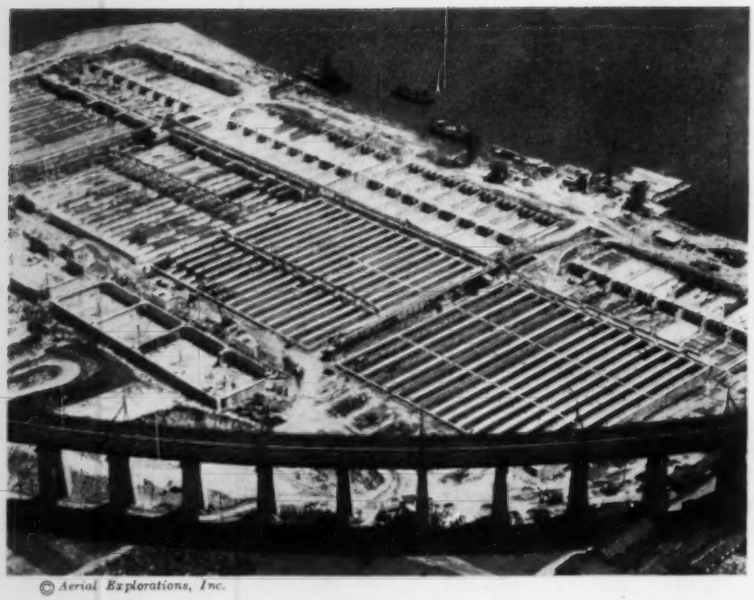


PLATE BOX CONCRETE DISTRIBUTED BY MIXER TRUCK



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DISTRIBUTION OF CONCRETE BY LONG LINES OF BELT CONVEYORS FROM A CENTRAL MIXING PLANT

Construction of Ward[s] ment Work[s]

By RICHARD H. GOU[LD]

ENGINEER OF SEWAGE DISPOSAL AND INTERCEPT[ING]

ONE of the inspection trips arranged for visiting members during the Annual Meeting had as its objective New York City's activated sludge sewage treatment plant now under construction on Wards Island in the East River, opposite 110th Street. Since ground was broken in June 1931, rapid progress has been made on this plant, the largest of its type in the world. The complete paper was prepared by Mr. Gould for presentation before the Sanitary Engineering Division on January 19, at the Annual Meeting of the Society in New York.

This article gives a brief résumé of the purposes of the plant and describes a number of the novel con-

IN 1927 the New York State Legislature turned over to the City of New York about 52 acres of land on Wards Island for the site of a sewage treatment works. In 1928, following preliminary reports, a contract was made with Fuller and McClintock, Engineers, for the complete design of a plant of the activated sludge type with a capacity of 180 mgd. At the same time, preliminary plans for intercepting sewers were started in the offices of the borough presidents of Manhattan and the Bronx. Since the formation of the Department of Sanitation on December 1, 1929, the entire project has been under its jurisdiction.

REINFORCED CONCRETE VENTURI METER 72 by 40 In., on the Influent Line

The Wards Island project has been previously described in CIVIL ENGINEERING for November 1931, and will be but briefly reviewed here. The plant will receive the drainage to the Harlem River and part of that to the East River from both Manhattan and the Bronx. The general plan proposed consists of intercepting sewers constructed along the water front of Manhattan and the Bronx, bordering on the Harlem River and nearby sections of the East River, through which sewage and storm water up to the amount of twice the dry-weather flow of the tributary area will be passed. The sewers in the tributary area, which are on the combined system, lie at such an elevation along the water front that tide gates will be necessary to prevent the harbor water from flowing back into them. The interceptors will lead to a coarse screening and grit chamber in each borough for the removal of heavy grit and other material that might obstruct the tunnels and pumps. From the grit chambers, deep-lying tunnels in rock under the East River will conduct the sewage to the pumping station on Wards Island.

The pumps on Wards Island will lift the sewage about 45 ft to the preliminary settling tanks. These tanks, eight in number, are to be mechanically cleaned by mechanism of the revolving type and provide for a detention period of about one hour. Flows up to $1^1/_2$ times the average dry-weather flow will be passed to the aerating tanks, and excess flows at times of storm, up to twice the dry-weather flow, will be passed through the preliminary tanks. The surplus not passed to the aerating tanks will be discharged into the river through an overflow conduit.

The aerating tanks are 16 in number and have such capacity as to provide an aerating period, with one tank out of service, of $5^1/_4$ hr at the average flow of 180 mgd, plus 25 per cent return sludge. The tanks are of the spiral-flow type with curved baffles, and the waterway is 22 ft wide by 15 ft deep. The tanks are of the four-pass type, giving a total length of flow of about 1,380 ft. Air is to be admitted through porous plates at the bottom of one side of each channel. Piping and control facilities are to be housed in an operating gallery.

From the aerating tanks the sewage passes to the final settling tanks. These are 32 in number and, with two of the tanks out of service, have a rated capacity of 1,000 gal per sq ft per day at average rates of flow, plus 25 per cent return sludge. The sludge will be removed from the final settling tanks by sludge removers of the mechanical conveyor type. Discharge to the river is through two conduits ending at the bulkhead line.

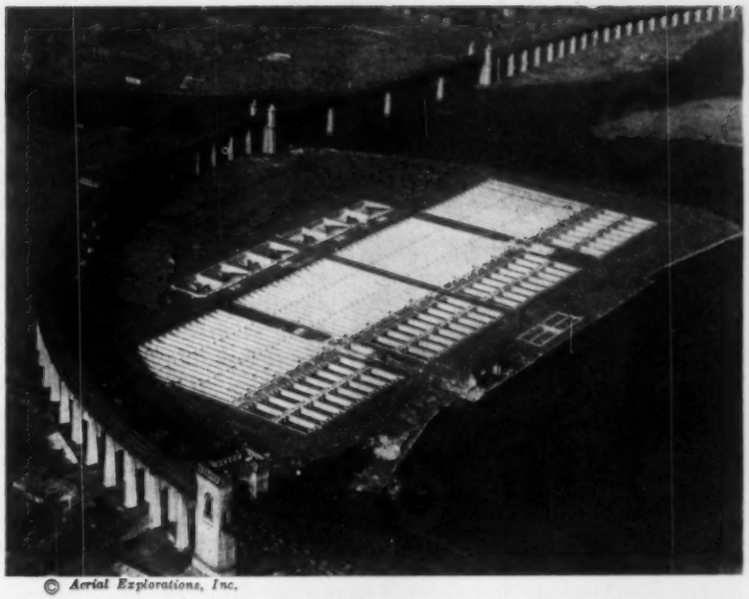
POURING DIFFUSER PLATE BOXES IN AERATION TANKS

Island Sewage Treatment Ahead of Schedule

MEMBER AMERICAN SOCIETY OF CIVIL ENGINEERS

ENGINEERS, DEPARTMENT OF SANITATION, NEW YORK, N.Y.

Construction features which contributed to the unexpectedly rapid progress of the work. Belt conveyors, both fixed and portable, assisted in solving the problem of placing over 100,000 cu yd of concrete in forms spread over an area of 40 acres. The shifting of movable forms on converted truck chassis and the building of tank bottoms above tide level, greatly facilitated the construction. Both air and sewage are measured by large Venturi meters. The largest of these, 6 ft in diameter, which is cast in concrete, is used to measure the influent. Although a four-year construction period was anticipated, the two contracts have been practically completed in 18 months.



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PRELIMINARY TANKS, AERATORS, FINAL TANKS, AND DOCK COMPLETED
Photograph Taken in January 1933

The return sludge pumping units are to be set up in two separate stations, four pumping units in each station, each with a capacity of 15 mgd. Filtered and compressed air for the aerating tanks will be provided by six motor-driven centrifugal blowers, each having a capacity of 42,500 cu ft per min. These units will be located in the main pump and blower house and will supply air normally at a pressure of $7\frac{3}{4}$ lb per sq in.

The sludge removed from the settling tanks will be pumped to a decantation and storage tank located on the water front. A dock is provided there so that specially constructed ocean-going tankers can receive the sludge and carry it out to sea. Provisions are to be made so that surplus liquid can be decanted from the storage tanks and returned to the treatment works in order to limit the volumes for shipment as much as possible. To meet state and Federal regulations, the sludge must be dumped at a point ten miles from the nearest land, and this will entail a round trip of about 65 miles.

TWO CONTRACTS NEARLY COMPLETED

Earlier estimates indicated that the cost of the intercepting sewers and treatment works would be about $30,000,000. At present prices, it is thought that this cost will be under $24,000,000.

In the spring of 1931, bids were received on Contract A for the dock and sea wall, and on Contract B, for the tanks and operating galleries. Work was authorized to start on June 18, 1931, under Contract B, and on June 22, 1931, under Contract A.

Courtesy U.S. Pipe and Foundry Company

42-IN. METER IN INFLUENT LINE

Contract A, for the dock and sea wall, carried out by the Frederick Snare Corporation of New York, has now been completed at a cost of about $804,000. In conformity with the requirements of the city charter, this work was carried out under the supervision of the Department of Docks, with F. T. O'Keefe as Chief Engineer, and William C. Crosby in immediate charge of construction. The Department of Sanitation, however, maintains general control of the work.

Contract B includes the construction of the preliminary and final tanks, aeration tanks, operating gallery, substructures of the sludge pumping stations, foundations for the storage building, conduits, and piping. The work was awarded to W. H. Gahagan, Inc., of Brooklyn, for about $3,900,000. A subcontract for the concrete work was given to the Turner Construction Company. Subcontracts for the clarifying equipment in the preliminary tanks went to the Dorr Company, and that in the final tanks to the Link-Belt Company. This selection was based on the relative prices bid on carefully prepared alternate designs for both types of equipment.

It is interesting to note that the Gahagan Company's estimate was nearly $700,000 lower than the next bidder and about $2,300,000 below the early engineers' estimates, based on pre-depression prices. A time limit of four years was allowed, but the bulk of the work was finished in 18 months.

The work is now nearly complete, and indications are that its cost will be less than the sums shown on the bid sheets. The amount of extra work has been almost negligible. This is an indication of the completeness of

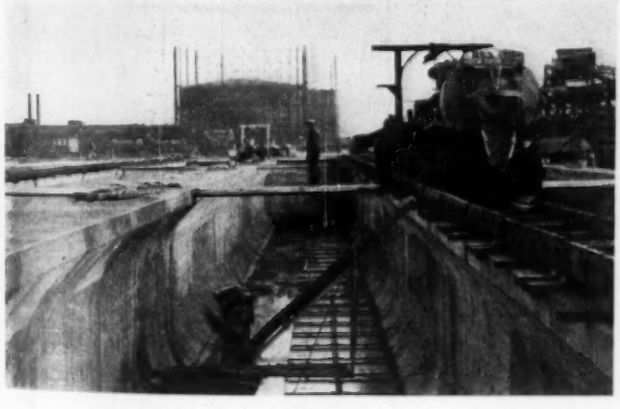


PLATE BOX CONCRETE DISTRIBUTED BY MIXER TRUCK

the plans and specifications and the care with which the work was executed. Excellent results have been secured on both contracts, and the fullest cooperation has been given at all times by the contractors.

For the completion of the treatment works, about 20 additional contracts are required. These, which may total about $7,000,000, will include the pump and blower house; the administration building and laboratory; the superstructures; the sludge storage facilities; the sludge vessels; and the heating plant and other miscellaneous installation that may be required to complete the project.

AERATION TANK CONSTRUCTION PROVIDES SPIRAL FLOW

The designs for the intercepting sewers, grit chambers, and tunnels are now about 50 per cent completed and will be finished this year. If appropriations are secured when needed it will be possible to finish the entire project and place the plant in operation by 1936.

CAREFUL PLANNING RESULTS IN RAPID PROGRESS

Perhaps the outstanding features of the construction of the tanks and operating galleries were the methods used by the contractors, which resulted in unexpectedly rapid progress. The excavation was efficiently handled by gasoline and oil-operated shovels, motor trucks, and "bulldozers." The concrete placing was highly mechanized, only about five men being used on the mixing plant. The bulk of the concrete was placed in the forms by a system of main-line and portable conveyors resulting in rapid delivery and low labor costs. Cranes and special mechanical devices were used for shifting the forms. The system used was planned by R.C. Wilson, Vice-President of the Turner Construction Company, and proved successful in meeting the progress schedule.

The administration of the construction work has gone ahead smoothly, facilitated by the completeness and clarity of the plans and specifications and the reasonable attitude of the contractors. The two sets of contract plans contain about 100 sheets. These have been supplemented by 24 auxiliary drawings and sketches, about 141 revision sheets, and approximately 380 drawings submitted by the contractors.

Payment for the work is on the unit price basis. The amount of bookkeeping and accounting is large, as the work is subdivided under more than 200 separate items and classifications. This large number of items was in part due to the setting up of a number of alternate divisions, made necessary to secure bids on sludge-removal mechanisms of different types.

Separate payment for items such as cement, for example, has facilitated the accounting, as it has been possible to adjust the quantity of cement in the different types of structures in accordance with particular requirements and still keep the amount used within reasonable limits. The frequent tests made indicated that a good quality of concrete was being secured at all times.

The plant was so laid out that the elevation of the bottoms of the tanks was for the most part above high-tide level. The entire area occupied by the aeration tanks was covered by a system of underdrains leading to tidewater. These were provided with check valves to prevent back flow. From a design standpoint, these drains obviated the necessity for providing against ground-water uplift in the large areas of tank flooring, when the tanks were empty. This system was also of considerable advantage during construction. It was found that it permitted the rapid drying out of the tank bottoms, eliminated mud holes, and helped in shaping up and consolidating the foundation for the tanks.

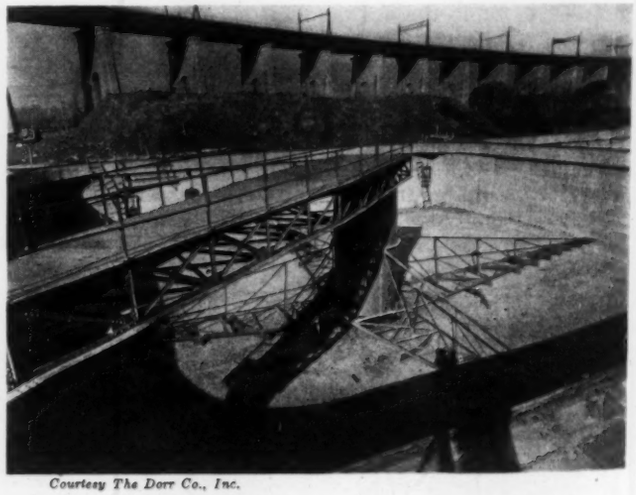
All of Battery A was in rock excavation, and the pits of the operating gallery throughout its entire length were founded on rock. Foundation conditions on the whole were excellent. There was only one small area of bog, which was located in the northeast corner of the plant. This was removed and replaced by solid backfill. Excavation, both in earth and rock, was relatively simple. It totaled about 325,000 cu yd of earth and 70,000 cu yd of rock.

EXPANSION JOINTS PROVIDED

The entire plant was carefully laid out between definite expansion joints. At these joints, water stops consisting of steel or crimped copper plates were used, and the joint was filled with a cushion of asphalt sheet mastic. This detail required considerable care in the construction of the joints, but it is anticipated that little trouble will result from temperature changes.

Somewhat more than 105,000 cu yd of concrete were placed in the works. During the fall of 1931 and the winter of 1932, concrete was mixed at a temporary plant served by an existing dock at the water front and was distributed by means of mixer trucks to various isolated points in pits, operating galleries, conduits, and pumping stations, as required. Portable belt conveyors operated by gas engines were used to place it in the forms.

On completion of a part of the permanent dock in the spring of 1932, a central mixing plant was established in which the bulk of the concrete was mixed. Sand and gravel were placed in the hoppers by a crane directly from barges. Cement came to Wards Island in bulk, on barges, and was placed in the cement hopper by compressed air. A single batching machine served two $1\frac{1}{2}$-yd mixers into which the sand, gravel, and cement were automatically weighed. Concrete was discharged on to main-line belt conveyors 1,860 ft long, from which it was taken off on to portable belt conveyors. The



Courtesy The Dorr Co., Inc.

ONE OF THE EIGHT PRELIMINARY SETTLING TANKS
Dorr Revolving-Type Mechanism

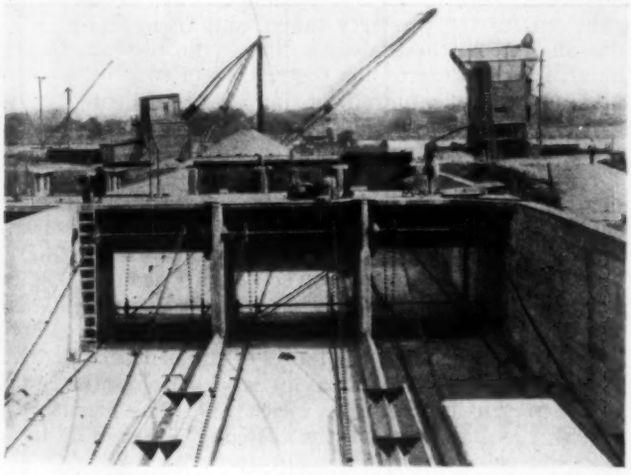
portable conveyors were mounted on wooden trestles, which were rolled laterally as the work progressed to permit the placing of the concrete directly in the forms of the aeration tank by means of short chutes.

The average rate of pour in this central mixing plant was 800 yd per day. Owing to the subdivision of the work by the expansion joints, it was necessary to pour in about 20 different locations each day. An interesting problem, from the contractor's viewpoint, was the pouring of the aeration tank walls, aggregating $4^1/_2$ miles in length. These walls were 17 ft high and flared on both sides, top and bottom, to a curved section. The contour of all walls was the same, so that the forms could be used many times. Much study and some experimentation were required for the design of the forms, so that they would be strong enough for rapid filling to full height and capable of easy handling. A metal-lined wooden type was used. The forms were shifted by several motor-truck chassis on which were mounted special A-frame carriers and winches.

Piping involved the use of 3,500 tons of cast iron in sizes from 6 to 66 in. in diameter, as well as about 1,170 gates and valves from 6 to 72 in. in diameter. For the measurement of sewage and air, 40 Venturi meters up to 72 in. in size were used. In most cases the pipes and valves were set up in the forms before the concrete was poured. The schedules for placing the piping and for casting and placing the diffuser plate boxes and connections were worked out to coordinate with, and closely follow, the major concrete placing operations in the rest of the plant.

AIR DIFFUSER PLATES REQUIRE SPECIAL ATTENTION

The diffuser plate boxes were cast on the floor of the finished aeration tank. They were poured from the top of the aeration tank wall, using a small mixer truck running out on the tank walls on a wooden runway. Specially designed apparatus was used to handle the forms and set the finished boxes in place. The boxes were steam cured except during the very hot weather.



ONE OF THE 32 FINAL SETTLING TANKS
Link-Belt Conveyor-Type Mechanism; Flights Not Installed

The same wooden runway on top of the aeration tanks was used to set the cast-iron air laterals inside the flared top of the tank walls.

Precast slabs of concrete were used over the air-line laterals laid in the trough at the top of the aeration tank walls. These slabs, which also served as a walkway, were provided with cast-iron inserts so that they can be removed for any repairs to the air laterals that may become necessary. They were cast and cured in a separate plant at the northwest corner of the site. Concrete for this purpose was supplied from mixer trucks, the mixed concrete being drawn off from the end of one of the main-line belt conveyors.

The eight preliminary tanks are about 100 ft square and are equipped with a revolving mechanism of the tractor type, mounted on a central pedestal and actuated by motor drive on a rail set on the top of the tank walls. The surface of the tank floors was formed by a mortar coat poured on the roughened concrete base and finished in place by the mechanism itself. This method has resulted in close adjustment between the floors and the scrapers.

PIPING IN THE OPERATING GALLERY
Air Measured by Venturi Meters

The 32 final settling tanks were equipped with conveyor mechanisms. The floors of these tanks were finished in place by hand. Rails set in the floor, later to serve as bearing strips for the flights of the mechanism, were used as screeds for the finishing process. No mortar coat was used, as in the case of the final tanks. The general results were good, although a certain amount of surface grinding was required to make exact adjustment with the course of the conveyor flights of the mechanism.

The construction of the dock and sea wall under Contract A called for the excavation of considerable rock to secure adequate berthing depth for the sludge vessels. The dock itself included two types of construction—one the pile and relieving platform type, and the other the stone-filled wooden crib type. The sea wall was faced with granite, part being on a pile and platform base and part on a stone-fill base.

The rock on which the crib-type dock was built proved to be much more disintegrated than was anticipated and was found to break in such a manner as to necessitate a considerably deeper crib structure than was originally planned. This and other conditions caused a considerable overrun in the quantities of this work. This same rock and the revised section of crib dock dictated the use of concrete filled steel piles for the foundation of the sludge storage building along the side adjacent to the dock.

PERSONNEL

The detailed design for the Wards Island Sewage Treatment Works was made by the firm of Fuller and McClintock, in collaboration with the city's engineers. This firm was assisted by Pearse, Greeley, and Hansen on the plant design, by Sloan and Robertson on the architectural features, by Noel Chamberlin on the landscape work, and by Cox and Stevens on the design of the sludge vessels.

The construction work and the design of the intercepting sewers are under the direction of the Department of Sanitation engineers, under Commissioner Leonard C. L. Smith, M. Am. Soc. C.E., Engineer Member, with A. R. Glock, Assoc. M. Am. Soc. C.E., acting as resident engineer; William L. Sylvester, Assoc. M. Am. Soc. C.E., as designing engineer; and the writer, in charge.

Equitable Distribution of Benefit Assessments

Basic Principles as Applied Specifically to Street Widening Projects

By Hymen Shifrin

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Assistant Chief Engineer, Division of Sewers and Paving

Department of the President, Board of Public Service, St. Louis, Mo.

THE problem of equitable distribution of benefit assessments resulting from the execution of city planning projects, has been brought to the foreground by the unusually extensive condemnation of private property that has taken place in a large number of progressive municipalities within the last ten years. The basic principles underlying an equitable determination of benefits and their proper distribution, are similar for all types of city planning projects, even though the nature of the benefits may differ. An important recommendation made by Mr. Shifrin is that the usual practice of first determining the cost of the project and then raising the amount by assessing arbitrary benefits, be discontinued. The benefits should first be estimated and then those projects in which the benefits do not cover the cost of acquiring the necessary property should be eliminated from further consideration. The original paper, of which this is an abstract, was presented on January 19, 1933, before the City Planning Division at the Society's Annual Meeting in New York.

IN 1923, an $87,000,000 bond issue was passed in St. Louis, covering the comprehensive needs of the city. A part of this sum was made available for a ten-year street widening program. According to the constitution of the State of Missouri, the condemnation of private property for public purposes, and the assessment of benefits are entirely judicial matters. As usual where court litigation is resorted to, these proceedings consumed a long period of time. Even though the ordinances authorizing the condemnation were all passed shortly after 1923, it has been only within the last three or four years that actual levying of benefit assessments in connection with such condemnation has taken place. However, a number of such levies were made in this period, and in some instances overlapping of assessments for more than one project occurred.

As a result of the current practice of determining special assessments and also of the wave of economy due to the economic depression, public opinion in St. Louis became sufficiently crystallized to demand a revision of this practice. In the early part of 1931, the Chamber of Commerce of the City of St. Louis appointed a committee of engineers, lawyers, and business men to study the question of special assessments. This committee, of which I am a member, reviewed the proceedings of a majority of the large street widening projects where the legal steps involving the condemnation and the assessment of benefits had been completed, and in most instances where the actual physical construction had been finished. The studies of this committee form in part the basis of the recommendations made in this article.

While times were prosperous and business conditions good, a large number of municipalities held successful elections at which bonds were voted for the execution of such projects as were recommended by the planning bodies. In some instances the bond funds were used to pay the entire cost of the project; in others they covered only a part of it, the remainder being paid from funds obtained by levying benefit assessments against private property. The latter practice is the one followed in the City of St. Louis. However, in both cases, practically the entire cost is borne by taxes on the real property of the community. In St. Louis, for instance, 80 per cent of the revenue collected in general taxes is obtained from real estate. Such a procedure may reach those that receive the greatest benefit from the completed project, but it does not seem equitable to secure the funds in this indirect way when it is feasible to assess a tax directly on those who are chiefly benefited.

The detailed procedure followed in the condemnation of private property for public use and in the assessment of benefits, varies with the constitution of each state. In general, however, because of the right of eminent domain granted to governmental bodies, the acquisition of property by condemnation is handled in the state courts. The assessment of benefits in some states is made a part of the condemnation procedure; in others it is assigned to the administrative branch of the government. In either case the equity of both the awards for condemnation and the distribution of assessments depends primarily on the qualifications of the men making such determinations. This has been forcibly impressed on the citizens of St. Louis, where three commissioners are appointed by the circuit court to determine both the damages and benefits in such cases.

It was found that the commissioners determine first the amount of damages to be paid out for the property taken, and then, according to the amount of these awards, assess the benefits against an arbitrarily determined district, from which the major part of the sum required for damages is collected. The rest of this sum is borne by the city, and comes either from general funds or from special bond issues voted for the specific project. In laying out the district for the assessment of benefits, the area chosen usually has been of sufficient extent so that only a small assessment was made against all but the abutting property. It is wholly due to the fact that the amount of the benefits assessed against individual pieces of land has been relatively small, that there has not been more litigation contesting the validity of such benefits and of the limits of the benefited district.

If street widening and paving work is to continue, and at the present time in most cities it is by no means completed, the major part of the cost must be paid by those who derive the benefits. Let us briefly examine the basic principles in use for the determination of benefits.

The fundamental principle that the value of any piece of ground is directly affected by the degree of its accessibility, or conversely, that lack of accessibility causes land values to depreciate, is well established. Determination of the amount of the benefits resulting from a street widening project and of their equitable distribution is the specific problem under consideration here.

Inasmuch as benefits bear a direct relation to the need that created the demand for the contemplated project, it would appear logical in a proper analysis of the amount

of the benefits to determine specifically the needs that justify the proposed improvement. Such an analysis, when applied to street widening, results in the classification of four types of benefits, as follows: those (1) to users, (2) to business centers served by the street to be widened, (3) to abutting property, and (4) to outlying

WIDENING OLIVE STREET AT 12TH STREET, ST. LOUIS
45 Per Cent of Cost Paid Out of Bond Issue Funds

areas through increased accessibility to focal points. A discussion of these four types of benefits follows.

1. As a rule, a proposal for street widening is the result of recommendations made by the city plan commission, or some similar body, after an exhaustive traffic survey and study of existing conditions. In most instances, such a recommendation is based on the necessity of furnishing increased roadway facilities to relieve aggravated congestion, and to accommodate the anticipated increased volume of traffic that the studies indicate will occur. The immediate beneficiaries, therefore, of the widened street are without question the automobile and truck owners, who are provided with greater roadway capacity. Under the present system, no part of the cost of a street widening project is directly assessed against such beneficiaries.

2. The second reason for undertaking a street widening project is to stabilize property values in the business centers of the city. The decentralization that has been taking place in our large municipalities during the past two decades is a direct reaction against the difficulty of access to the old parts of such cities. Widening of important streets serving such centers makes them more approachable, and therefore property owners in the section derive material benefits from it and should bear a part of the cost. However, assessments against such property are often severely criticized by the owners. Their objections are frequently valid, because the usual practice of first determining the damages and then fixing the benefits to cover such damages often results in arbitrary assessments.

3 It would appear, without question, that the properties abutting on a street to be widened are materially benefited. Past experience, however, has proved that any immediate benefit to this property is highly speculative, and that ultimate benefits do not occur until the improvements along the widened street have been reconstructed so as to produce the increased revenue made possible by the completed project. Such of the improvements as are not disturbed by the new construction, if not of a character benefited by an increased volume of traffic do not receive any immediate benefits. Merely widening a street and permitting a greater volume of traffic to pass along it without providing for services to cater to the added traffic, does not in itself benefit the abutting property. As a matter of fact, in some instances it has proved detrimental because of the increased difficulty and hazard to pedestrians crossing the highway.

In order that the abutting property may benefit from the completed project the needs of the increased traffic must be met by the establishment of such facilities as filling stations, garages, and accessory salesrooms. A second reconstruction made possible by the completed widening project is the opportunity to utilize a greater part of the lot, thereby increasing the income through greater floor space. This is because, in most cities, the street width is the basis on which the zoning laws limit the height of structures and the part of the lot to be occupied. Since the benefits to the abutting property do not occur until the character of the improvements has changed, property owners should not be required to pay for such benefits until a sufficient time after the completion of the project to permit the reconstruction of the improvements. Of course, it is realized that economic conditions determine this time interval, and that an average period would have to be adopted. The carrying charge due to a deferred payment for such benefits would form a part of the cost of the completed project.

4. As a result of the increased capacity created by the widened roadway, large areas are brought closer to the focal points served by it, through decrease in the time necessary to reach them. The practice of assessing benefits against property in the so-called secondary and tertiary districts, at a relatively low rate, decreasing with the distance from the widened street, has been followed in St. Louis and in other municipalities. The total amount so assessed in many instances constitutes a very large percentage of the totai cost of the project. Such a procedure can only be justified on the ground that assessments against real property furnish a means of certain collection, and result ultimately in an indirect assessment on the user. If the direct assessment on the user, previously suggested, is made, assessment against contiguous areas, which must of necessity be entirely arbitrary, should be avoided as much as possible. It is this assessment that has aroused public opinion.

To ensure the equitable distribution of benefit assessments, it is not only necessary that the benefits be properly determined, but it is equally important that the tax be levied against all those benefited by the completed construction. In the case of street widening projects, state constitutions should enable the establishment of metropolitan districts to include all adjacent areas within which the tax against the users receiving immediate benefits through the use of the added facilities could be levied. The outstanding example of such a district for a specific purpose is that created in the vicinity of Boston, and now known as the Massachusetts Metropolitan District. Not only should state constitutions permit the establishment of such districts within the state, but a further step should be taken to make possible the creation of metropolitan districts to cover areas in more than one state. This type of district is necessary when a large city is situated along the border lines of states. An example is the Port of New York Authority. Such other benefits as may accrue can generally be levied only on the area within the corporate limits of the municipality, in which the actual physical work is being carried out.

Within the metropolitan district, or within the corporate limits of the city if the formation of such a district is not permitted by existing laws, the form of tax to be

levied against the user—the automobile and truck owner—may take three forms, as follows:

1. Based on the benefits to the user, and determined according to a comprehensive plan prepared by the city plan commission, the tax may consist of an addition to the gasoline tax above that levied for other highway or street purposes. If a metropolitan district cannot be established, making it necessary to levy such a tax on only the residents within the municipality, an appreciable loss in revenue will occur because residents near the city limits will purchase their supply outside the city, where the additional tax is not imposed.

2. A second plan for taxing the user, and one more equitable where no metropolitan district can be created, is to increase the automobile license tax Under such a plan, all residents within the city or district limits would have to pay such an additional amount as might be considered necessary to cover the benefits received by them from the planned improvements.

3. A third form of tax, which has the same defects as the gasoline tax, is a wheel or tire tax.

It would seem, therefore, that probably the most feasible and equitable plan for assessing benefits against users would be to impose an automobile license tax to be added to the existing tax.

A proper organization for the efficient handling of city planned projects should include, in addition to a city plan commission or some similar body, a board of assessors, either as part of the department of public works, or as a section of the fiscal department of the municipality. This board of assessors would carry out the preliminary work and determine finally the taxes to be levied as benefit assessments for completed projects. This would not interfere in any way with the present constitution of most states, which requires that the determination of damages to be paid for property taken through condemnation by governmental bodies must be handled by the courts of the state. The value of the property acquired or the amount to be paid for it should in no way affect the determination of benefits. It is very desirable that the practice of determining the cost of a project and then finding means of raising the amount by assessing arbitrary benefits, be discontinued.

Before any project is definitely taken up, a complete major street plan covering the anticipated needs of the municipality for a definite period of years should be prepared and transmitted to the department of public works. The board of assessors should then analyze each project in order to justify its construction. Before any estimates are made of the cost of acquiring the necessary property, a complete estimate of benefits should be prepared, based on the three types of benefits previously described. Benefits to the user can be definitely determined by estimating the total volume of traffic for which facilities are being created, and the saving afforded this traffic as a result of the decreased time required to travel the route. Benefits to business centers and anticipated benefits to abutting property may also be determined by the board of assessors, who will finally estimate their total.

When the total benefits have been determined, the cost of the project should be estimated and divided into two parts: (1) damages to be paid for private property to be acquired in connection with the project, including the carrying charges for deferred benefits and the cost of clearing the site of all improvements and (2) the cost of paving construction.

After the estimates of benefits and damages for the projects proposed by the planning commission in its comprehensive major plan have been computed, only those projects in which the benefits equal the damages should receive further consideration. Those projects where, in the opinion of the assessors, the cost cannot be justified by the accruing benefits, should be abandoned. If a project is found to be justified, the board of assessors should prepare complete and detailed preliminary plans and estimates and inform all property owners affected as

WIDENING OF OLIVE STREET, ST. LOUIS, COMPLETED TO 100 FT

to the cost to them of the completed work. This publicity is very necessary in order to deter disgruntled property owners from organizing when the project has almost reached the construction stage, and entering objections on the ground that they were not informed of the contemplated project and the cost to them. Every effort should be made to prevent charges of inequitable or arbitrary assessment.

The practice followed in the City of St. Louis during the last ten years, has been to assess only the cost of constructing a street of ordinary width against the private property that regularly pays for such improvements, and to pay the excess cost, that for increased roadway width and heavy base construction, out of the 1923 bond issue funds made available for the city's share.

Whether or not bond funds are available, it would seem proper that state highway departments should turn over to the municipalities or metropolitan districts a part of the state highway funds paid in by the residents of these areas. This would provide funds to pay the excess cost in connection with major streets, which generally are continuations of state highway routes.

It is of course realized that projects would have to be carried out within a relatively short period of time, and that sufficient funds could not be raised on the pay-as-you-go plan described. However, with the adoption of a comprehensive plan as a result of the preliminary studies suggested, and the establishment of a metropolitan district for the levying of a special automobile license tax, there would be a sound basis for the issuance of bonds. The annual total of the tax to be collected to cover the benefits to users could be estimated fairly accurately. To this sum should be added the estimated amounts to be collected in the future as deferred benefits. These funds could then be capitalized in the form of a bond issue to such an amount that the interest and sinking fund necessary for amortization would be entirely paid out of the benefit assessments collected annually. A definite schedule of progress could be prepared, considering not only the amounts to be collected annually but also the ability of the property owners in the business centers and along the streets to be widened to pay for the benefits assessed against them.

Control of Pavement Cuts

Methods Used to Reduce and Coordinate Surface Cuts for Utility Structures

AN amazing yardage of permanently paved streets in American cities is cut into each year to lay, replace, or repair the public utility structures beneath. The engineering departments of many municipalities have found it imperative to coordinate their improvement programs with the plans of the utility companies so that the underground work will precede the paving. Coordinated planning has saved much cutting of city streets. In spite of this planning, during the five-year period, 1925–1930, approximately 40 per cent of the pavement on First Avenue, New York, between 34th and 42d streets, was replaced as a result of necessary cuts, and 3 per cent of the total paved street area of the city was cut into and replaced in the single year of 1931. The authors of the two articles that follow state the procedure used in New York and in Washington, D.C., to limit the number of cuts made and to make sure that repairs are expedited and made permanent. The papers from which these articles have been prepared were read before the Highway Division on January 19, 1933, at the Annual Meeting of the Society in New York.

Practice in New York City

By R. A. MacGregor

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ENGINEER OF MAINTENANCE, BOROUGH OF MANHATTAN, NEW YORK, N.Y.

MOST cities attempt to reduce the number and extent of cuts in pavements by requiring or encouraging the installation of the main utility lines before the paving is done and by warning utility companies and property owners that openings will not be allowed for a certain period, one year or more, after the pavement is laid. This method is successful to some extent, as the cost of replacing a high-class pavement is a considerable item in the installation of subsurface utilities. But a burst water main or house connection, a leaking gas main, or a broken and leaking sewer must be repaired and to do this the street pavement must be broken into.

In New York, before the first paving is done it is generally required that the sewers and gas and water mains shall be laid. In the Borough of Manhattan, before repaving is started, the subsurface corporations are permitted to lay new lines or repair existing lines without having to pay for the pavement restoration. Permits for such work are called "ahead-of-paving" permits and require only a temporary pavement to replace that removed.

Formerly in New York the practice was, and in other cities still is, to install spurs and even carry the house connections to the curb for each lot on both sides of the street on all sewers built, but this has been discontinued as an unnecessary expenditure of capital. If the sewage has to be pumped or treated, the unused connections are responsible for a large increase of flow from infiltration of ground water. The seriousness of the problem may be realized to some extent from the fact that a total of 30,000 permits for openings were issued in 1931 and that in Manhattan alone from 1,000 cuts (in these times of depression) to 1,600 or more (in busy seasons) are reported each week as ready for restoration. The average area of such cuts is about 7 sq yd, and the total area of cuts restored in Manhattan in 1931 was 350,600 sq yd, more than 3 per cent of the entire paved area of the city (11,000,000 sq yd).

The procedure in Manhattan, and in the other boroughs also, unless noted, is first to present an application for an opening in the pavement to the Division of Permits. This application states the name of the applicant—plumber or corporation—the location and purpose of the work, and the estimated time required to complete it. If made by a corporation, the application is usually accompanied by a sketch, as the Department of Water, Gas, and Electricity controls or attempts to control the location of subsurface structures so as to protect its water mains. The phrase "attempts to control" is used advisedly, because in Manhattan it is necessary in most of the streets for a corporation to make test pits and explorations to find room for any new ducts or structures. In other boroughs there is not in general so much crowding, and it is possible to lay out and assign definite locations for the various utilities, thus separating high and low tension electric lines, for instance.

With the application a deposit is made, directly in cash or check if by an individual, or indirectly by charge against a standing deposit or bond if by a corporation. This deposit is to cover the cost of restoring and inspecting the pavement, and of issuing the permit. A flat charge of $1 is generally made for the permit, and the amount of the restoration charge is based on the kind of pavement and the estimated area likely to be disturbed. In Manhattan the deposit is $40 for a water connection and $60 for a sewer connection, but this is doubled in the case of individual permittees to provide for a second restoration of the opening if the pavement settles owing to improper backfilling. This system of double deposit, used only in Manhattan, has reduced the amount of careless backfilling by plumbers to a remarkable extent. The risk of losing a refund of $40 or $60 at the end of six months acts as a great incentive to careful backfilling.

The permit itself constitutes a receipt for the deposit, since the right-hand edge, on which amounts in dollars and cents are printed in columns, is cut off at the proper amount. It also states the time limit, the purpose of the opening, whether night work is permitted, and the name of the permittee. This permit must be kept on the job for inspection by the police or other authority. From the stubs of the permit books a complete list in

triplicate is made up of each day's issue, giving the permit number and the purpose of the opening. One copy of the list remains in the Permit Division; one is sent to the Cost Division and one to the Maintenance Division. In addition to this complete list, small forms are made out in triplicate giving the information contained in the permit—the number, date, location, name of permittee, and length of time allowed for the work. One copy, marked "Preliminary Report," goes to the patrol inspector, and two go to the Division of Maintenance. Of these, one, marked "Tickler," is retained there, and the other, marked "Final," is sent with the work order to the city gang or paving company gang making the restoration.

REGULAR PATROL OF STREETS PROVIDED IN THE BOROUGH OF MANHATTAN

Manhattan is the only borough that has a complete system of regular patrol and inspection of streets. It is divided into 21 sections, each with a patrol inspector. In addition to keeping track of openings, he makes a complete inspection of his district each week. He covers it in five days and reports conditions requiring attention, such as cave-ins, worn areas, and openings, whether or not he has been notified of them. The work done by corporations is inspected by special inspectors, known as corporation inspectors, appointed by the city but paid by the corporations. These men observe the work up to the completion of backfilling, when the cut is turned over to the district patrolman. In the case of plumbers' openings, the patrolman can give only occasional supervision.

As soon as the backfilling is done, a statement of the fact is recorded on the preliminary form together with a sketch of the location and dimensions of the opening. The location is given by reference either to the street line at the end of the block or to the house line (between two house numbers) and to one of the curbs. This preliminary form is sent direct to the Maintenance Division and is used for the issuance of work orders to the paving gangs, the sketch location being copied on the work order whether for a city gang or for a paving company.

These preliminary reports are sent to the Maintenance Division day by day, and in addition each Monday every patrolman makes up, for his district, a "cut list," in which he records all cuts ready for restoration but not yet restored. For the assistance of the Maintenance Division, the cuts are listed according to the agencies (city, individual, or corporation) by which they were made and by which they are to be repaired, if a repaving order has been issued. Those cuts for which no repaving order has been issued are listed separately. This cut list gives the date when the backfilling was completed and therefore the age of the cut in days. From this list five-day notices to corporations and 64-hr notices to paving contractors on guaranteed streets are made out.

A summary from the cut list is prepared for the Maintenance Engineer, showing the number and area of the cuts to be restored by the city and by each of the various paving companies, as well as those for which no work orders have been issued, and the total number and area of the cuts in each of these classifications. This summary reaches the Maintenance Engineer on Tuesday or Wednesday.

Another summary from the cut list is made by the Patrol Division to show the number of cuts under the headings "no order," "1–10 days," "10–20 days," "over 20 days," and "covered by building materials," in each of the 21 patrol sections. This is sent to the Principal Assistant Engineer and then to the Maintenance Engineer, who already has the summary of the cuts chargeable to each paving company and to his own forces.

RESTORATIONS CHARGED TO PERMITTEE

On receipt of the preliminary report by the Maintenance Division, a work order containing the information and sketch in the report is sent to the city gang or to the guaranteeing paving company. The work orders to concrete, stone-paving, and asphalt gangs are similar but of different colors for convenience in filing. As soon as the concrete work is done, the order is returned by the gang foreman, and the top or wearing-surface order is issued to the stone or asphalt gang.

The gang foreman records on his work-order card and also on the final form the actual dimensions of the restored area, which may be larger than the preliminary area because of undermining or wear and tear on the edges of the cut. On his daily time sheet he records the job number and location of the cuts restored, and on his materials sheet, the quantities used for the day's work. The work orders and the time sheets then go from the Maintenance Division to the Cost Division for the computation and issue of bills against the permittee or his deposit. If the restoration is made by a paving company on a guaranteed street, the final form is given to the city inspector accompanying the company gang and by him filled out, sent back to the Maintenance Division, and then to the Cost Division for billing to the permittee.

This procedure is required in Manhattan because the permittee is charged for cost to the city whether the work is done by a city or a company gang. Then, as previously stated, a refund is made or an extra amount is charged, according to circumstances. The practice varies in the other boroughs. In some, the original deposit is predetermined according to the location, type of pavement, and assumed dimensions of the cut, and no refund is made. In others, a fixed deposit is charged according to type of pavement, and a refund or an additional charge, at an established price per square yard, is made according as to whether the cut is larger or smaller than the average size assumed.

In Manhattan, cuts restored by corporations or for them by paving companies are treated in the same way except that the only amount billed to the permittee is that for the time of the inspector accompanying the paving gang. Manhattan is the only borough using the double deposit system and the only one charging only for labor, materials, and overhead, or the price actually paid to the guaranteeing paving company plus the cost of inspection.

In cases of urgency, requiring opening after office hours, such as a bad gas leak or blow-out on electric lines, a permit is secured from the Police Department at once and a regular permit is obtained from the Borough President's Office when that office opens.

NO TIME ALLOWED FOR SETTLEMENT OF BACKFILL

It is the aim of the Manhattan Maintenance Division to have pavements restored in the shortest possible time after backfilling is completed. No time is allowed for settlement, it being considered that the cost of a second restoration is more than offset by the reduced inconvenience to the traveling public. It can be safely asserted that with proper care in backfilling, only a slight settlement should occur. The double deposit from individuals and the placing of responsibility on corporations practically ensures this needed care. As a matter of fact, the corporations frankly admit their responsibility and restore a pavement without argument. Their point of

view is that "The Public be pleased" is the right attitude.

If the pavement is still under guarantee, the restoration of openings is made with the same material as that of the pavement removed, both for foundation and wearing surface. If the guarantee has expired, all cuts are restored with granite if in a granite pavement, and with sheet asphalt if in asphalt, wood-block, or asphalt-block streets. This simplifies maintenance work, as the same practice is used for ordinary repairs due to wear. Occasionally, to accelerate restoration, a black base of close binder is used in streets such as Fifth Avenue and in the midtown district.

The area of cuts in some streets is surprising. In the five years of guarantee, 1923–1928, on Fifth Avenue between 42d and 59th streets, 8,330 sq yd of cuts were made in a total area of 29,550 sq yd, or about 28 per cent. On First Avenue between 34th and 42d streets, from 1925 to 1929 (five years), 6,220 sq yd of cuts were made in a total area of 15,280 sq yd, or about 40 per cent. However, these are extreme cases.

A report of the age of cuts for a week in September 1932 listed the following:

Cuts less than 10 days old	802
Cuts from 10 to 20 days old	252
Cuts over 20 days old	78
Cuts covered with building materials	9
Total cuts ready for restoration	1,141

In the busy season of normal years, the number of cuts covered with building materials would be a larger proportion of the whole, but the other classes would be in about the same proportion, and the total would be from 1,600 to 2,000. Cuts in the last class are segregated so as not to constitute a discredit to the paving organizations, and to show the reason for delay in restoration.

Practice in Washington, D.C.

By H. C. WHITEHURST
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THERE is perhaps no phase of municipal highway activity that presents so many difficulties or causes so much distress to the paving engineer as does the control and repair of cuts or street openings in improved pavements for utility structures. It can truthfully be said that in the modern city the utility cut is the engineer's greatest enemy; all his calculations on the life and wearing qualities of a pavement can be upset within the space of a few years by excessive and promiscuous cutting for underground work, much of which is unnecessary. Information is constantly being sought to overcome this difficulty, particularly by the large cities. The real solution of the problem lies in careful planning before the pavements are laid, rather than in attempting to prevent or minimize subsequent street openings by means of heavy penalties or fees. In nearly every large city there has been considerable criticism, both of the utility companies for not planning underground structures in advance of paving, and of the city, for not giving due notice to underground agencies long enough ahead to permit this planning.

CONTROL ESTABLISHED IN 1929

To exercise control of work in public areas and to coordinate the various surface and subsurface activities of utility companies and District departments engaged in public improvement work, the Office of Coordinator for the District of Columbia was organized late in the fiscal year 1929, with the Director of Highways as the executive head. This office was authorized to pass on applications for street openings for underground work, to secure releases from underground and surface agencies before construction of permanent types of pavements, and to issue, on application, time assignments for all work in public areas other than service connections—in short, to control all work and obstructions in public space, including time of performance.

The present system of coordinating surface and subsurface work requires that the initiative be taken by the Director of Highways and the Coordinator. It is the policy to inform public utility companies and all surface and subsurface agencies of proposed street improvements as far in advance of the actual accomplishment of the work as possible. This is done so that they can make a study of their needs and coordinate their proposed improvements and extensions to meet the requirements of the highway department's program. The Coordinator's Office issues to all the various agencies that may have work to execute in public areas, a tentative list of proposed street improvements. This list is issued in the spring preceding the fiscal year during which the improvements are to be undertaken. At a later date—usually December—a definite schedule of the proposed construction is forwarded to each agency, accompanied by sketch drawings of each project, showing definitely and accurately the limits of the work and the area to be paved.

When the schedules and drawings are returned by the utility companies, the proposed underground work and all data pertaining to it are carefully analyzed and summarized, and a schedule is issued to all interested agencies setting forth the order in which the proposed work is to be executed. Those paving projects in which the extent of proposed underground work prohibits paving during the working season are postponed so as to allow sufficient time for this work in advance of paving. In addition, the various agencies are invited to submit a schedule of major projects to be performed, irrespective of highway work. Frequently a study of these influences the general planning of highway projects scheduled for later consideration.

ADVANCE PLANNING FOR UTILITIES

The whole plan of arranging for underground construction in advance of paving is one of complete cooperation between all agencies. With this cooperation, the procedure has been found to be very flexible, additions and eliminations being made at will without serious inconvenience. The system has resulted in a great saving of time and money for all concerned and has brought the

District departments and utility companies into closer contact.

This problem of completing the construction of all underground installations in advance of paving is approached through the consumer as well as through the producer. Each owner of abutting property is notified by letter of the proposed improvement and its scheduled date and is urgently requested to have a thorough inspection made of all his services in order that any necessary work within the affected area may be done prior to commencement of the improvement. Also, the thoroughfare is posted for at least a month before the work is started, the posters stating the nature of the improvement and calling attention to the desirability of carrying out all underground construction in advance.

Applications to make cuts in existing pavements are passed on by the Coordinator's Office after careful study, first, to make sure that the street opening is necessary, and second, to avoid if possible the cutting of a permanent roadway. Reduction in the number of cuts has been brought about mainly through release activities, by notifying property owners of intended improvements, by careful study of applications to avoid unnecessary cuts, and by hearty cooperation and advance planning by the underground agencies.

SIMPLE BUT EFFECTIVE ORGANIZATION

Inasmuch as the work is so closely allied to the Highway Department, final responsibility has been vested in the Director of Highways as Coordinator and directing head. Working directly under him and doing the necessary detailed work are two engineers and one inspector, this work requiring not more than 25 per cent of their time. One of these engineers, a member of the Highway Department staff, serves as release engineer and handles the preparation of all release lists and the compilation of reports. He also keeps the construction engineers informed of the progress of the underground work. The other engineer plans and controls the location of all underground work in public areas. All requests and plans for construction prior to paving, or those involving cuts other than service connections in existing pavements, are approved by him. As a result many pavement cuts are prevented and thousands of dollars are saved to underground agencies by better location and advance planning. The inspector in the office of the Coordinator handles all applications and time assignments.

In addition to the personnel working under the direct supervision of the Coordinator, each surface and subsurface agency has appointed a coordinator with whom the District Coordinator's office deals directly. These men are of sufficiently high rank in their respective organizations to speak with authority for them.

The ultimate success of any plan to control utility cuts by advance planning is dependent on the full cooperation and support of the underground agencies. This support can only be obtained by providing distinct benefits and financial gain for the utilities. In the District of Columbia, the obvious interest taken by the municipality in the welfare of the utilities immediately led them to show not only the necessary cooperation but also deep interest in the success of the method.

Contrary to the belief of some, a plan to control utility cuts does not have as its purpose the stopping of underground repairs or extensions. Quite the contrary is true; any city in which some underground work is not always in progress may be immediately classified as non-progressive. The plan is: (1) to ensure planning and construction of underground structures in advance of paving, (2) to obviate the necessity of future cuts by timely notices calling the attention of all interested parties to the impending improvement, (3) to study the needs for special locations and to provide them where desirable, and (4) to prevent destruction of pavements.

Washington's plan was designed with a threefold purpose: (1) to control the cutting of existing pavements by carefully investigating all applications for permits, (2) to ensure adequate planning and construction in advance of paving by a system of releases from underground agencies, and (3) to require time assignments for work in public areas so as to ensure proper sequence of work, check utility construction, and prevent traffic congestion.

SUCCESS OF PLAN IN WASHINGTON, D.C.

In Washington, D.C., the plan has been in operation for a little more than three years. During the first year the number of permits was 4,000 less than in the preceding uncontrolled year. The next year saw a slight increase, due primarily to increased Federal Government activity, which required the removal of the power company's substations in the heart of the city and installation of greatly increased facilities for the Federal Triangle. The year just past, which ended June 30, 1932, saw a decrease of more than a thousand permits, although there was an extensive program of replacement of gas by electric lamps, requiring about a thousand permits more than were issued for this type of work during the previous year.

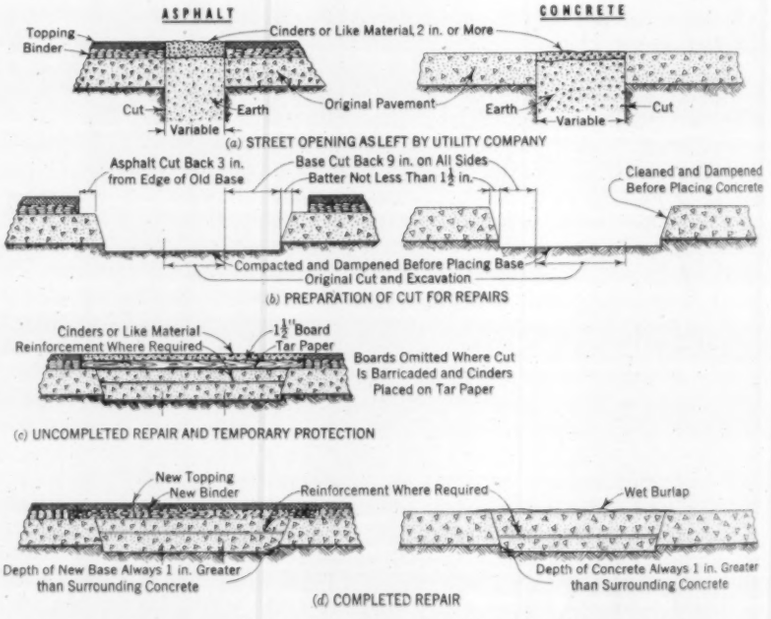

FIG. 1. METHOD OF REPAIRING PAVEMENT CUTS IN WASHINGTON, D.C.

While the plan is fully justified by the encouraging decrease in total cut permits, its most significant success lies in the fact that, except for emergency leaks or breaks, less than ten permits have been issued for cutting pavements less than two years old. These facts indicate beyond doubt that the system of advance planning and controlled releases is operating for definite good.

What Is a Navigable Waterway?

Some General Principles Governing Legal Status and Required Clearances

By G. B. PILLSBURY

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IN recent years, particularly, considerable attention has been given in engineering circles to the subject of navigability of inland waterways. General Pillsbury points out that this question is generally raised by those not interested in navigation, because if a stream can be used for navigation it is by court definition navigable. He states that the determination of navigability is a question of public right and therefore is a matter of law and not of engineering opinion or economics. This authoritative paper was presented by General Pillsbury on January 19, 1933, before the Waterways Division at the Society's Annual Meeting in New York.

WHAT is a navigable waterway? It is precisely what the term implies, a waterway that can be usefully navigated. The question is of importance, however, since if a river is navigable it is a public right of way, and the public right to its reasonably unrestricted use is guarded by the provisions of the Federal law. Furthermore, the ownership of the bed of a stream may, and generally does, hinge on its navigable status.

Navigable streams are public rights of way for the same basic reason that established land routes are public rights of way. The bays and inlets on the coast, and the rivers traversing the interior, were the highways for the settlement of the country. The present network of good roads and railroads has supplanted many of the smaller and less efficient streams as transportation routes. The former value of these rivers may be appreciated by observing the use made of such streams in the few remaining regions without roads and railroads. The question, "What is a navigable waterway?" never arises in a pioneer region. All rivers are there recognized by common consent as public ways which may not be closed to free and unrestricted public travel.

Establishment of the right to the free use of the waterways, untrammeled by state restrictions, was one of the impelling reasons for the establishment of the Federal Government. After the Confederation of States had won their independence from Great Britain, several of the states placed restrictions on the use of their waterways to the disadvantage of their neighbors. When the Federal Constitution was adopted, it reserved for Congress the power to regulate commerce with foreign nations and among the several states. The commerce our forefathers had in mind was commerce by water. Railroads and modern roads were not dreamed of when the Constitution was written. In adopting the commerce clause of the Constitution, they had in view that Congress, and not the State of New York, should regulate the use of such waterways as the East River.

Since the navigability of a waterway is a question of public right, its determination is a matter of law and not of engineering opinion or economics. The final decision as to whether or not this right exists is inherently one to be made by the courts. The power to terminate such a public right rests solely with the people, through their representatives in Congress. No executive authority may decree that a stream is navigable or not navigable. Just as a city engineer may be asked whether a certain road is or is not a public right of way, so the U.S. Engineer Department, in its administration of the navigable waterways of the United States, is often called upon for information as to whether a given stream is navigable. But its answer must be based on law and fact, and not on economic advisability.

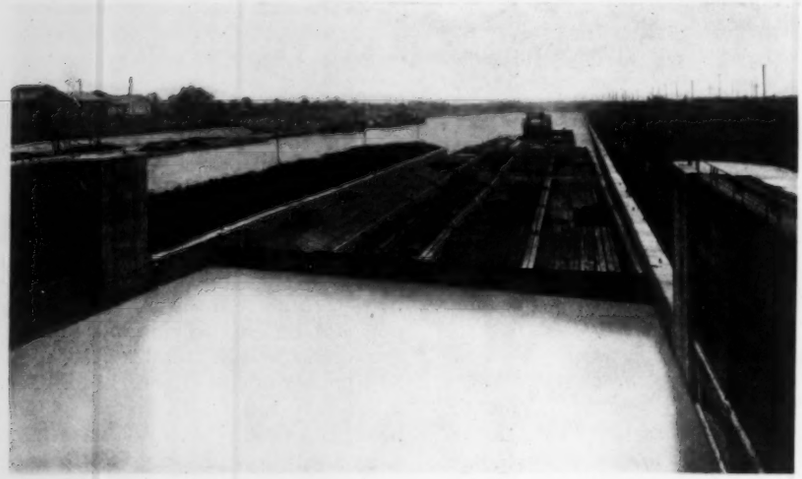
The Supreme Court has laid down a clear rule for determining the navigability of a waterway. Rivers are navigable in law as in fact, if they are used, or are susceptible of being used in their ordinary condition, as highways of commerce over which trade and travel can be conducted in the customary way by water; and they constitute navigable waters of the United States, within the meaning of the acts of Congress, when they form, in their ordinary condition, by themselves or by uniting with other waters, a continued highway over which commerce is or may be carried on with other states or with foreign countries. Obviously, nearly all rivers that reach the sea form a continued highway under this rule, and if navigable in themselves are navigable waters of the United States and under Federal jurisdiction. Interior lakes lying wholly within a single state, and without a navigable outlet, as well as the upper reaches of some rivers on which continuous navigation is not possible

LOCK NO. 9 ON THE KENTUCKY RIVER
Looking Upstream from Below the Abutment

"DOUBLE-HEADER" ON THE SACRAMENTO RIVER, CALIFORNIA
Two Steamboats Towing Barges Loaded with Grain

even by portage, are navigable waters of an individual state, and are not under Federal control.

The application of this rule is simple when a river, like the Hudson, is in active use for trade and transportation. It is clear, also, that the public has no inherent right to the use of a mere brook meandering through farm lands. But between these two extremes lies a wide twilight zone in which are many streams, once used to a greater or less degree in the lack of better means of travel, but now not used at all. It is significant that the very river to which the previously mentioned Supreme Court decision related, the Grand River in Michigan, up to Grand Rapids, was considered unquestionably navigable when the decision was rendered some sixty years ago, the only point at issue then being whether it was a navigable waterway of the United States or of the State of Michigan. To the modern eye the Grand River at Grand Rapids is now patently unnavigable. All traces of its use for commerce have disappeared from the mind of man as from the river itself.



A STEAMER AND TOW LOADED WITH STEEL
Entering the Louisville (Ky.) Lock on the Ohio River

The issue is complicated by the fact that the ordinance of Congress for the government of the Northwest Territory, enacted 145 years ago, provided that its navigable waters, and the carrying places between them, should be common highways forever free. Therefore, in this rich and populous part of our country, a waterway once established by the early fur traders as a route of commerce cannot revert from its status of legal navigability, no matter how long transportation on it has been suspended. Whether or not in other regions the navigable status of a stream may lapse from disuse does not appear to have been determined by the courts.

OCCASIONAL USE DOES NOT INDICATE NAVIGABILITY

It has been held by the courts that the mere sporadic and occasional use of a stream for the flotation of logs or poles, or even by steamboats at high water, does not make it navigable. Where, therefore, there is no present navigation and no history of a well established prior use for trade and transportation by water, the stream may be considered as not navigable. But the determination must be based on the facts as to public utilization, and not on the present economic justification for preserving the public right of way. A public highway cannot be closed by administrative authority on the ground that it is no longer economically necessary.

It is not possible to fix a standard of size and character of a stream or of its slope, velocity, or discharge, as a criterion of navigability, any more than it is possible to define the width, grades, and surface of a road required to make it a public highway. The modern high-powered launch has made possible the use for transportation of certain streams in the undeveloped regions of the West and Alaska, which are so full of rapids that they once would have been considered unnavigable. I doubt whether this fact confers any status of navigability on similar streams in the East, where navigation has never developed.

The navigable status of a waterway affects, as a rule, the ownership of the underlying land. Under the English law, lands under navigable waters belong to the Crown. In this country, on the formation of a state, the lands under navigable waters have usually, if not always, passed to the state, even though the Federal Government retained the public lands in the state. Lands under water, while usually of little or no intrinsic worth, may have valuable gravel deposits and in oil regions may be highly valuable. It follows, therefore, that state governments often have a decided interest in maintaining the navigable status of their rivers. Whatever the ownership of the bed, it is subject to the easement of use for navigation, and the Federal Government may, without compensation, excavate or fill and erect structures required for the betterment of navigation.

It is within the power of Congress to declare a stream non-navigable, and this power is occasionally exercised. As is to be expected, Congress is chary of extinguishing a public right when objection is made thereto, and has declared unnavigable only certain unimportant streams where local sentiment was wholly in favor of the action.

INQUIRIES AS TO NAVIGABILITY OF STREAMS

The question whether a given river is or is not navigable is almost invariably raised by those not interested in navigation. This is necessarily the case, since if navigation were a present or even a definitely prospective actuality, the stream would be unquestionably navigable.

NAVIGATION ON THE KENTUCKY RIVER AT FRANKFORT, KY.
A Packet and a Tow of Barges Loaded with Oil and Coal

For the same reason, the question of navigability rarely arises within the War Department, since there is no occasion to invoke the laws for the protection of navigation if there is no present navigation to be protected. Inquiry as to the navigability of a river not now navigated is usually made by those proposing to build a structure spanning the stream, and who desire, for

reasons of financing, to comply strictly with the letter of the law if the stream has a legal navigable status. Because of the number of such inquiries, the U.S. Engineer Department has recently made an investigation of the navigable status of a considerable number of rivers not now used for navigation, and is in a position to give a well considered opinion as to their technical navigability.

The Federal law provides that it shall not be lawful to construct any bridge, dam, dike, or causeway across a navigable waterway without the consent of Congress, unless the navigable sections of the waterway be wholly within a single state, in which case authority for construction may be granted by the legislature of the state; and the law requires also that after this legislative franchise has been granted, the plans for the structure shall be submitted to, and approved by, the Chief of Engineers and the Secretary of War before construction is begun. If, therefore, a bridge is to be constructed across an interstate navigable river, an Act of Congress to authorize the construction must be secured. The state charter of the constructing agency usually confers the requisite state authority.

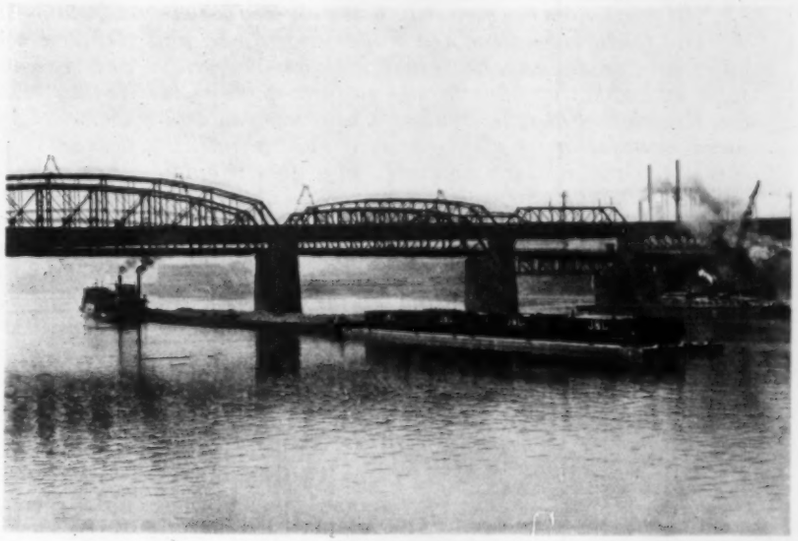
The approval of the Chief of Engineers and that of the Secretary of War normally relate solely to the clearances to be provided for navigation. Needless to say, navigation interests are insistent that the clearances be sufficiently ample to afford safe and easy passage. Since wide and high spans add greatly to the cost of a bridge, the interest of the builder is often in opposition. The practice of the War Department for all but unimportant bridges, is to hold a public hearing at which both sides may fully present their case. It often happens that this hearing results in the submission of revised plans for a mutually satisfactory structure. Otherwise the case must be settled by the War Department on the basis of the facts presented.

For various reasons, which space prevents enlargement upon, the craft used for the transportation of freight on our interior rivers require bridges of greater headroom and span than do the craft used on European rivers.

BRIDGE OVER THE OHIO RIVER AT LOUISVILLE
Dredging Below Lock No. 41

I think it is clear that the bridges in this country must be built to accommodate American locomotives, American trucks, and American water craft.

When the navigability of the waterway is doubtful, those proposing to construct a bridge often submit plans for approval to be on the safe side. It is not the present policy or practice of the War Department to require clearances for navigation where no navigation exists, but it has long been its view that it should not approve plans for bridges that do not afford adequate room for the passage of floods. When a flood occurs in any part of the country it is usually found that obstructive bridges have contributed materially to the damage, and there is then a demand that supervisory agencies see that bridges provide adequate room for flood waters. Unfortunately, the local memory of flood damage is short lived. Perhaps the Federal Government has a longer memory. To this circumstance may be ascribed the clearances required for some bridges over rivers on which there is no present commerce.



CAR FERRY AND TOW OF COAL
On the Monongahela River at Pittsburgh, Pa.

It is not difficult to find drawbridges over rivers on which commerce is now non-existent, but an examination of the bridge will usually show that it antedates the construction of the hard-surfaced roads that have supplanted the river as a means of local transportation.

The Federal laws for the protection and preservation of its navigable waters also require Federal approval of plans for wharves, piers, pipe lines, and other encroachments on navigable waters and, in fact, for any works that alter or modify the navigable capacity of a waterway, but no legislative franchise is required for such construction.

POWER DAMS ON NAVIGABLE RIVERS

The provisions of the Federal Water Power Act make the question, "What is a navigable waterway?" of concern to engineers engaged in power development, since under this act a Federal license must be secured from the Federal Water Power Commission before a dam may be constructed for power production on a navigable river. Since the Federal Power Commission has to do with power, and not primarily with navigation, the question may become acute on streams that have no navigation. It appears likely that the pending New River case will clarify the definition of navigability arising from the administration of this act.

In summary, the navigability of a waterway is inherently the existence of a public right to use it for trade and transportation. If the question is viewed in the same light as that of a public right of way on land, the application of a rule of reason should afford a correct answer.

Coagulants for Water Purification

Use of Alum and Ferric Compounds for Floc Formation

FOR years alum has been in common use as a coagulant for turbid waters, and a number of American cities have made their own alum in lump or syrup form by combining bauxite and sulfuric acid. At the Montebello Filters in Baltimore, however, a modern alum manufacturing plant has been built to utilize this coagulant in dilute solution and to feed it automatically into the raw water in proportion to the flow. In the first of the following articles, Mr. Armstrong presents an abstract of the paper he read before the Sanitary Engineering Division on January 19, 1933, at the Annual Meeting of the Society. In it he describes the processes and the mechanical difficulties that were overcome at the Montebello plant.

Ferric compounds have been used for both water and sewage purification, and their use is increasing as they become more available. Many hitherto little understood characteristics of ferric coagulants were brought to light by the complete and elaborate series of experiments conducted by the authors of the second article in this symposium, as described in the paper read by Professor Bartow before the Sanitary Engineering Division on January 19, 1933, at the Annual Meeting of the Society. Only a brief abstract of the paper is possible here but the complete report may be consulted at Society Headquarters.

Manufacture and Control of Liquid Alum

By JAMES W. ARMSTRONG

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FILTRATION ENGINEER, BUREAU OF WATER SUPPLY, BALTIMORE, MD.

MONTEBELLO Filters at Baltimore comprise two plants, one with a normal capacity of 128,000,000 gal, put in operation in 1915, and the other with a capacity of 112,000,000 gal, put in operation in 1928. The old plant was equipped for the use of lump alum and on that account the equipment necessary for making lump alum was installed in the new plant when it was built and was used for a short time. The quality and quantity of the output were entirely satisfactory from the first, but the cost of breaking the cake and the work involved in transporting, handling, and dissolving it were so much greater than that required for making liquid alum, that the process was abandoned.

In making liquid alum, it is only necessary to bring together the ingredients in such a way that the resulting chemical reactions can be watched and controlled. No artificial heat has ever been used at Montebello, as that generated by the mixing of the chemicals has been sufficient to complete the reactions. However, these take place in less time, and are more satisfactory, in summer than in winter when the water and acid are cold.

Some latitude is admissible in proportioning the bauxite and sulfuric acid. In making liquid alum the proportions of 575 lb of bauxite and 1,120 lb of 60-deg Baumé sulfuric acid diluted with about 50 lb of water were used as the equivalent of one ton of lump alum.

HANDLING THE ACID

Sulfuric acid is transported from the factory 12 miles distant by a 5-ton truck, to the frame of which is fitted a cylindrical steel tank mounted on wooden skids. The acid has a specific gravity of about 1.8 so that the maximum load of six tons is contained in a small cylindrical tank having a capacity of 800 gal. The tank is made of $^5/_{16}$-in. steel and is unlined, as only 60-deg Baumé acid is hauled, and acid of that strength is not particularly corrosive to steel. It is withdrawn from the tank through a $2^1/_2$-in. pipe controlled by an acid-resisting bronze valve

There are three storage tanks for acid located in the basement of the chemical building, each of which holds 18,420 gal. They are made of $^1/_2$-in. steel plate, are unlined, and are supported by heavy structural steel saddles which extend up about one-third of the height of the tanks, to prevent their assuming an oval shape when filled with acid and breaking the connecting piping.

The specifications under which bauxite is purchased require that it shall be dried and crushed to eliminate lumps larger than $2^1/_2$ in. in diameter, and that it shall not contain over 2 per cent of moisture. They also require that it contain at least 57 per cent of dry basic aluminum oxide (Al_2O_3). The bauxite is ground very fine so that it enters more readily into chemical union with the sulfuric acid, and will quickly generate sufficient heat to make the chemical combination. At present, bauxite is purchased in carload lots from Bauxite, Ark., and is delivered in bulk.

The Montebello Filters are located two miles from the railroad, where the dry chemicals are delivered. Shoveling is required for loading trucks and some reshoveling is necessary for feeding the hoppers, but after the chemicals are once in the storage bins at the plants, no further manual work is required for rehandling or control. In order to make operation as convenient and safe as possible, all machinery in the new plant is driven by electric motors equipped for remote control, and is started and stopped by push buttons from the point most convenient to the operator.

Just before being elevated to the storage bins, the bauxite is passed through a pulverizer, shown in Fig. 1, where it is ground to the required fineness. A 20-in. fan is used to exhaust the finely ground bauxite from the pulverizer and discharge it through a 20-in. pipe into the 7-ft cyclone collector. This is located in the top of the tower 125 ft above the bottom of the pulverizer—an unusually high lift. From the cyclone collector the bauxite enters an 8-in. spiral conveyor, from which it can be spouted into any one of the storage bins through 6-in. steel pipes. These pipes have a minimum angle of inclination with the horizontal of about 60 deg. The air used for lifting the powdered bauxite is confined to a closed recirculating system which keeps it dry. A slight

amount enters through the automatic feeder, and any excess is withdrawn from the top of the return piping and discharged through a large tubular dust collector.

With the exception of the shaft in which the elevators and pipes are located, the entire area of the tower, which is about 60 ft square, is taken up with bins for the storage of lime and bauxite. The tower is constructed entirely of reinforced concrete and the bins are covered with a slab which acts as a floor for the spouting room above. A 24-in. manhole over a stationary ladder permits access to each bin. The bin bottoms slope 45 deg from each side to the center, and terminate at a large cast-iron plate, to which the spiral conveyors are attached. The conveyor under each row of bauxite bins is high enough to discharge directly into the weighing hopper of one of the three boiling tanks. The flow of bauxite from the bins is controlled by means of a flat steel gate, operated by a chain from the floor below.

For making the alum, three tanks of identical design, each having a capacity of 19,800 gal are used. They are 15 ft in diameter and have hemispherical bottoms suspended from 10-ft cylindrical sides. Each is supported by four H-columns riveted directly to the sides of the tank. In order that dust, vapor, and acid fumes may be removed, the tanks are covered with conical hoods connected with 20-in. vent pipes extending upward through the roof and terminating in ventilators. The tanks are made of steel plates $^{5}/_{16}$ in. thick, with lapped joints secured by a single line of $^{3}/_{4}$-in. rivets. On the inside of the tanks the rivets are flattened but not countersunk. The tanks were at first lined with sheet lead weighing 10 lb per sq ft. The hoods, made of $^{1}/_{16}$-in. steel, are protected on the inside with bitumastic enamel.

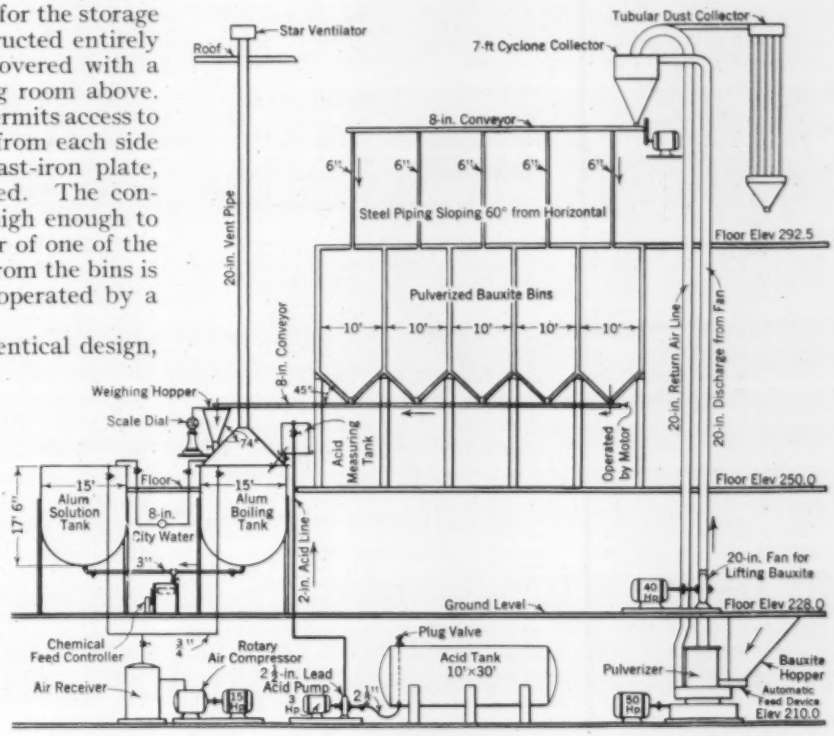


FIG. 1. DIAGRAMMATIC SECTIONAL ELEVATION THROUGH LIQUID ALUM PLANT
Montebello Filters, Baltimore, Md.

It was anticipated that occasional trouble with the lead lining might permit acid solutions to get between the lead and the steel. In order to detect any such leaks, the joints in the steel work were left uncaulked and a number of holes were drilled through the steel section of the tank bottom. These precautions proved valuable in detecting leaks but they offered little indication as to their position. This could only be learned by a careful inspection of all lead surfaces. The first cracks discovered in the lead were very small, but as time went on they increased in size and the difficulty of making satisfactory repairs became greater.

Each of the three boiling tanks has a steel weighing hopper for bauxite permanently suspended above it, which is connected to a scale provided with a large indicating dial. A separate 8-in. spiral conveyor supplies each hopper with bauxite. The conveyors are started and stopped by push buttons on the side of the boiling tank, so placed that the attendant can operate them while watching the dial. The hoppers have a capacity of about 4,000 lb and are made with very steep sides that slope 74 deg from the horizontal. Even then the bauxite sometimes sticks and makes it necessary to strike the sides of the hopper to loosen it. In order to keep down dust, the hoppers have light cotton duck connections at top and bottom.

Two lead-lined steel tanks, 5 ft in diameter, each holding enough acid for making one batch of alum, are used for measuring sulfuric acid. The tanks are supported by the boiling tanks and discharge the acid into the latter by gravity through a 2-in. lead pipe controlled by a solid lead valve. When it is desired to fill the measuring tank, the operator climbs a ladder secured to its side and pushes a remote-control button, which starts a $2^{1}/_{2}$-in. solid lead acid pump, located on the basement floor adjacent to one of the acid storage tanks, from which it takes suction. The bottom of each measuring tank extends a foot beyond the side and is turned up at the edge to form a saucer, which serves to catch any overflow or drips and convey them back to one of the boiling tanks. Because of the danger from the sulfuric acid, every precaution is taken to prevent accident.

As both the boiling and solution tanks for the alum have hemispherical bottoms, the solutions can be satisfactorily mixed and agitated by means of air. A simple $^{3}/_{4}$-in. lead pipe with a single or double outlet, controlled with a needle valve, frees the air at the lowest point.

About eight tons are made in each batch. A valve is opened admitting the prescribed volume of water to the boiling tank and then the contents of the acid measuring tank are discharged into the water. When sulfuric acid at 60-deg Baumé is added to water at 65 F, the temperature of the mixture rises in from 10 to 15 min to 125 F. At that point, which seems to be a maximum for the mixture of water and acid, about 1,000 lb of bauxite are added, and immediately the temperature of the mass begins to increase. Every few minutes from 200 to 300 lb of bauxite are added, until the entire batch of 4,360 lb has been admitted to the boiling tank. Shortly after this, the maximum temperature of from 225 to 235 F is reached. Then for a period of about a half hour the mass continues to boil, but the elevation of the surface keeps dropping until it reaches a point a little above the hemispherical bottom. Then, in order to prevent crystallization, dilution is begun. The entire process requires about $1^{1}/_{2}$ hr.

When the chemical reaction is complete, the mass is immediately diluted to a 10 per cent solution. Part of the solution is transferred by gravity through the 4-in.

pipe line to the old plant, and part is admitted to the dilution tank in the new plant, where it is reduced to a $2^1/_2$ per cent solution for application to the water.

As both the old and new plants are supplied by the same pumping station, it was necessary as far as possible to build them with the same hydraulic gradient. It was, however, anticipated that on account of the difficulty in maintaining uniform operating conditions, the flow to the two plants would vary considerably from time to time. In order to secure a flow of alum solution proportionate to the volume of water to be treated, an automatic chemical feed controller that would be reliable and positive in action was designed to operate on the difference in head between the intake and the throat of a venturi tube in the raw water main.

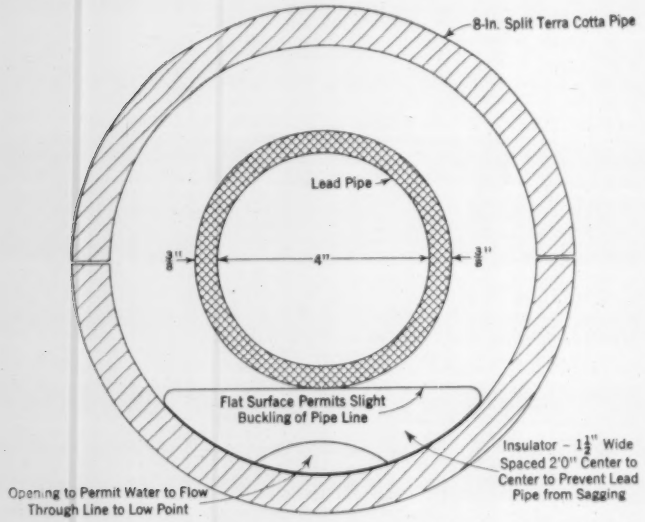

8-In. Split Terra Cotta Pipe
Lead Pipe
3/8"
4"
3/8"
Flat Surface Permits Slight Buckling of Pipe Line
Insulator – 1 1/2" Wide Spaced 2'0" Center to Center to Prevent Lead Pipe from Sagging
Opening to Permit Water to Flow Through Line to Low Point

FIG. 2. LEAD PIPE IN SPLIT TERRA COTTA FOR CONVEYING ALUM

It was found necessary to replace all the cast-iron alum pipe lines with solid lead, and all valves with solid lead valves. All the 4-in. lines were replaced with pipe $^3/_8$-in. thick, weighing 21 lb per ft, and all the 3-in. lines with pipe weighing 12 lb per ft. All the connections were made with cast-iron flanges of standard diameter and bolt circle, but the center was machined out to permit the flange to be slipped over the end of the pipe. The lead was then carefully peened over the flange, and when two such flanges were bolted together they formed a joint exceptionally free from leakage.

A new alum line 950 ft long, of 4-in. lead pipe weighing 21 lb per ft, was laid to connect the alum tanks in the old plant with those in the new. It is composed of 10-ft sections, welded together on the side of the trench. The only joints used were in the manholes, to provide for expansion, and in the bend at the low point of the line. The pipe was laid in an 8-in. split sewer pipe and was supported on insulators spaced 2 ft apart, as shown in Fig. 2. The insulators have an arched opening on the under side so that seepage water can flow through the pipe to manholes where it is drained away. So far, no trouble whatever has been experienced with this line.

Each of the three boiling tanks was originally lined with eight strips of sheet lead weighing 10 lb per sq ft. A steel strip $^1/_4$ in. thick and 3 in. wide, extending the full height of the tank, was bolted over each joint to hold the lead securely against the tank, so that no movement could take place along the joint either vertically or laterally. In order to protect the steel, it in turn was covered with a lead strip welded to the lead lining, as shown in Fig. 3. For a period of nearly two years the lining was in every way satisfactory, but after that time slight leaks began to appear, which grew steadily worse until they caused much trouble of an exceedingly aggravating type.

When the plant was first started, each batch of alum was diluted quickly, by opening a 4-in. water valve wide. This practice was continued until the trouble with the lead lining began, when the rate of admitting water was reduced to a very small stream, to prevent the sudden chilling of the lead lining.

Careful inspection revealed the fact that most of the trouble occurred where the steel plates of the tank lapped, or along the edges of the vertical strips of lead. The latter covered the steel strips that were used to hold the sheet lead in place.

Invariably the deepest and most pronounced cracks were on the concave or compression side of the plate, the place where they were least expected. Apparently the sheet lead expanded and buckled under the influence of heat. Following the line of least resistance, it started to bend at the places where there was an offset in the steel tank or where the rigidly secured steel plates resisted the movement in one direction. The buckling caused compression in the extreme fiber on the concave side, and when the tank was filled, the pressure of the liquid forced the lead back again against the side of the tank, but as lead under stress apparently does not expand and contract in accordance with Hook's law, the continued expansion and contraction caused a more or less crystalline condition, especially where the compression was greatest, until the metal lost its ability to resist tension.

After much research, expert advice, and discussion, it was finally decided to reline the tanks with lead $^3/_8$ in. thick, and to hang it from the top. The steel strips formerly used for holding the lead in position were omitted, and the lead sheets were joined by heavy seams, as shown in Fig. 3. The sheets weighed over a ton each, twice as much as the original ones, and were very much stiffer and harder to shape to the tank. The hood, scale hoppers, and dials had to be removed and replaced. The alum which had penetrated between the lead and the

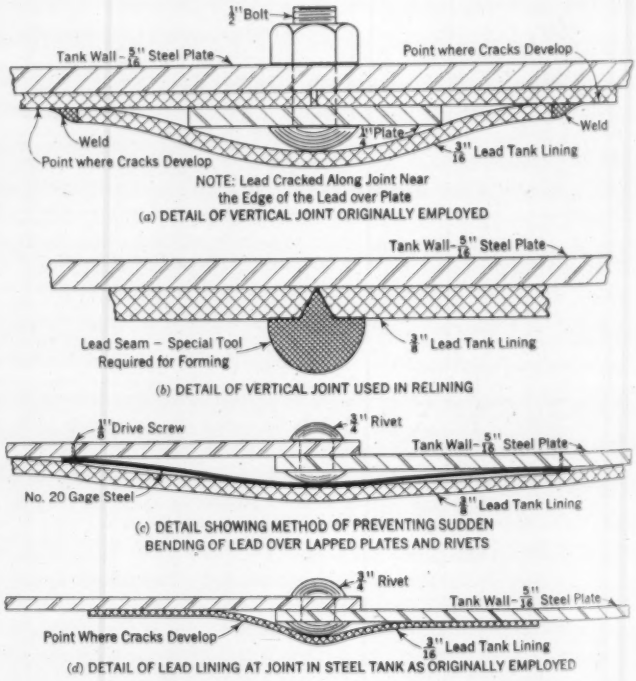
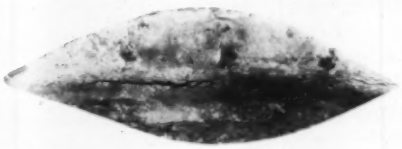

1/2" Bolt
Tank Wall – 5/16" Steel Plate
Point where Cracks Develop
Weld
Weld
1/4" Plate
3/16" Lead Tank Lining
Point where Cracks Develop
NOTE: Lead Cracked Along Joint Near the Edge of the Lead over Plate
(a) DETAIL OF VERTICAL JOINT ORIGINALLY EMPLOYED
Tank Wall – 5/16" Steel Plate
Lead Seam – Special Tool Required for Forming
3/8" Lead Tank Lining
(b) DETAIL OF VERTICAL JOINT USED IN RELINING
1/8" Drive Screw
3/4" Rivet
Tank Wall – 5/16" Steel Plate
No. 20 Gage Steel
3/8" Lead Tank Lining
(c) DETAIL SHOWING METHOD OF PREVENTING SUDDEN BENDING OF LEAD OVER LAPPED PLATES AND RIVETS
3/4" Rivet
Tank Wall – 5/16" Steel Plate
Point Where Cracks Develop
3/16" Lead Tank Lining
(d) DETAIL OF LEAD LINING AT JOINT IN STEEL TANK AS ORIGINALLY EMPLOYED

FIG. 3. METHODS OF ATTACHING LEAD LINING IN BOILING TANK

steel had corroded the steel to such an extent that sand blasting was necessary to clean it. As shown in Fig. 3, 12-in. strips of No. 20 gage steel were fastened with drive screws over each tank joint and line of rivets, in order to present a smooth surface for the lead to bear against. The inside of the tank was painted with two coats of red lead before the lining was placed. In lead welding, it is essential that the surfaces to be united be absolutely clean and bright. An oxygen and hydrogen flame is used as it is cleaner than the oxygen and acetylene flame employed for welding steel. The former does not give off enough impurity to tarnish the lead surface. The heavy seam could not be formed by ordinary methods but required a special tool.



A PIECE OF 3/16-IN. LEAD LINING, SHOWING CRACKS ON THE TANK SIDE DEVELOPED BY BENDING OVER THE RIVET HEADS

In considering the cost of making alum at Montebello, it should be remembered that the plant is built for the purpose of purifying water, and that the manufacture of alum is only one step in the process. Therefore, in a statement of cost, only those items are charged against its manufacture that actually increase the cost of construction and thereby add to the fixed charges, or that in some way increase the operating cost by involving repairs or extra labor. The cost of making liquid alum is given in condensed form in Table I.

TABLE I. COST OF MAKING LIQUID ALUM (2,000 TONS PER YEAR) Reduced to Units of One Short Ton of Lump Alum

ITEMS	COST PER TON
Sulfuric acid	
0.56 ton at $11.08 per ton	$ 6.20
Bauxite	
0.2875 ton at $14.76 per ton	4.24
Repairs	
$2,422 per year ÷ 2,000 tons per year	1.21
Fixed cost	
$3,858.50 per year ÷ 2,000 tons per year	1.94
	$13.59
Credit due to saving time of 3 men	
$3,942 per year ÷ 2,000 tons per year	1.97
Net cost per ton	$11.62

The buildings and all equipment except that used exclusively for the making of alum, would have been required for the regular operation of the filters had the alum plant not been built. For instance, the storage bins and the machinery required for filling and withdrawing chemicals from them are not included, and the tanks in which the alum solutions are made or diluted are included only in part, as they or some equivalent structures form a necessary part of the filter plant equipment.

Formation of Floc with Ferric Coagulants

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IT has long been recognized that ferric compounds can be employed in the formation of floc for the removal of color or turbidity from natural waters, but it is only in recent years that they have become available in adequate amounts and at a sufficiently low price to make it possible for them to compete with alum. Because of the possibility of increased use of these ferric coagulants, the authors undertook a study of them. It is known that aluminum salts and iron salts differ in their action when used as coagulants in water treatment, and the purpose of the study was to determine and explain these differences.

Four ferric coagulants are used in water purification: ferrous sulfate (oxidized by atmospheric air in the presence of alkali), ferric chloride, chlorinated copperas, and ferric sulfate.

Ferrous sulfate, or copperas, has been much employed as a coagulant since it was introduced in 1898 at Quincy, Ill. Since the coagulation takes place after oxidation to ferric salt by the oxygen of the air, ferrous sulfate is actually a ferric coagulant. This coagulant is unsuitable for the treatment of certain types of waters; soft colored waters or soft turbid waters are best coagulated on the acid side of the neutral point, pH below 7. With colored waters, the color appears to become fixed or set by the addition of alkali. The use of ferrous sulfate is therefore limited to those waters where alkalinity will not interfere with color removal.

Natural waters contain varying amounts of sulfate, chloride, sodium, calcium, and other ions. An experimental determination of the action of these ions on the formation of floc with ferric salts at different pH values shows the following results: (1) on the acid side the sulfate ion has a much greater effect on coagulation than the chloride ion; (2) using from 25 to 250 ppm of sulfate ion, there is but little change in the effect produced; (3) between pH 6.5 and 8.5 there is a zone in which ferric floc forms slowly or not at all; and (4) in and beyond this zone, sodium and calcium ions are most effective in coagulation.

The assumption of a change in the sign of the colloidal ferric floc from positive, where it is more affected by sulfate or chloride ions, to negative will explain the zone of no floc formation and the more effective action of the sodium and calcium ions beyond this zone.

The amount of residual iron in solution is roughly proportional to the time required for the floc to form.

In coagulation or formation of floc, the action of ferric salts is very different from that of ferrous sulfate. A very dilute solution (4 g per liter) of ferric sulfate, when treated with an alkali, has a pH value of 3 when 2 equivalents of alkali have been added; of 4 when $2^1/_2$ equivalents have been added; and of 7 when the 3 equivalents theoretically required have been added. With ferric chloride, the pH values are slightly higher. This means that a ferric floc may be formed in solutions much more acid than normally found in water works practice.

Ferric floc is not only more insoluble at lower pH values than alum floc, but is also more insoluble at high pH values. The possible pH range of floc formation is therefore decidedly broader on both sides of neutrality for ferric salts than for alum. Ferric floc as ordinarily formed has a higher specific gravity than alum floc and therefore requires shorter sedimentation periods.

ENGINEERS' NOTEBOOK

From everyday experience engineers gather a store of knowledge on which they depend for growth as individuals and as a profession. This department, designed to contain practical or ingenious suggestions from engineers both young and old, should prove helpful in the solution of many troublesome problems.

Calculating the Area of a Sector Between Two Circles

By MILES N. CLAIR

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VICE-PRESIDENT, THE THOMPSON AND LICHTNER COMPANY, INC., BOSTON, MASS.

AT various times in the work of the company, we have had occasion to determine the area of that part of

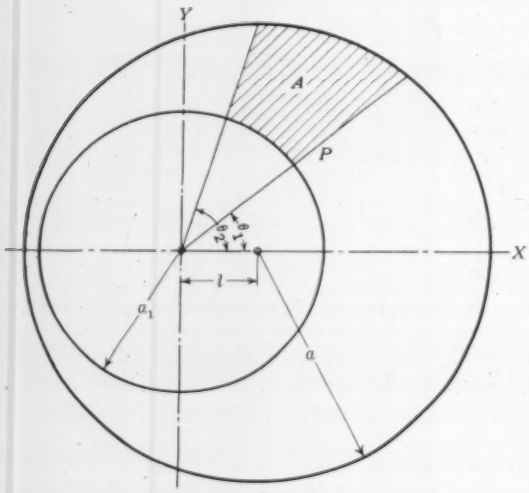

FIG. 1. DIAGRAM OF THE PROBLEM

a sector of a circle included between two circles, one inside the other, but not concentric with each other. On one occasion the problem involved the computation of the efficiency of an oil well pump, and on another the determination of the stress distribution on steel pipe columns encased in concrete. Recently it came up in the study of a marketing problem relative to the distribution of light-weight aggregates. A search of handbooks revealed no ready formula, so a solution was developed. This is presented here in the hope that it will be of use to others.

In Fig. 1, the radius of the including circle is a, the radius of the included circle is a_1, and the part of the sector lying between them whose area is desired is shown as A. Then

$$A = \int_{\theta_1}^{\theta_2} {}^1/_2\, \rho^2\, d\theta - \int_{\theta_1}^{\theta_2} {}^1/_2\, a_1^2\, d\theta$$

in which $a^2 = \rho^2 + l^2 - 2\rho l \cos\theta$,

or $\rho = l\cos\theta \pm \sqrt{a^2 - l^2\sin^2\theta}$

Substituting for ρ,

$$A = {}^1/_2 \int_{\theta_1}^{\theta_2} \left(l\cos\theta + \sqrt{a^2 - l^2\sin^2\theta}\right)^2 d\theta - {}^1/_2 \int_{\theta_1}^{\theta_2} a_1^2\, d\theta$$

$$= {}^1/_2 \int_{\theta_1}^{\theta_2} \left(l^2\cos^2\theta + 2l\cos\theta\sqrt{a^2 - l^2\sin^2\theta} + a^2 - l^2\sin^2\theta\right) d\theta - {}^1/_2 \int_{\theta_1}^{\theta_2} a_1^2\, d\theta$$

Integrating,

$$A = {}^1/_2 \left[\frac{l^2}{2}\sin 2\theta + \theta(a^2 - a_1^2) + l\sin\theta\sqrt{a^2 - l^2\sin^2\theta} + a^2\sin^{-1}\left(\frac{l\sin\theta}{a}\right)\right]_{\theta_1}^{\theta_2}$$

or

$$2A = \frac{l^2}{2}\sin 2\theta_2 + \theta_2(a^2 - a_1^2) + l\sin\theta_2\sqrt{a^2 - l^2\sin^2\theta_2} + a^2\sin^{-1}\left(\frac{l\sin\theta_2}{a}\right) - \frac{l^2}{2}\sin 2\theta_1 - \theta_1(a^2 - a_1^2) - l\sin\theta_1\sqrt{a^2 - l^2\sin^2\theta_1} - a^2\sin^{-1}\left(\frac{l\sin\theta_1}{a}\right)$$

Strength Tests of Old Mass Concrete

By WALTER M. SMITH

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A FEW months ago a number of tests were made by the U.S. Army Engineers on the mass concrete used in several lock structures of the Illinois Waterway. All the concrete had been in place for years, although the ages of the locks differed considerably. Likewise the depths from which the test cylinders were taken varied over a considerable range, thus throwing light on the possible effects on the strength of the material of having it set under pressure.

First, vertical cores were drilled, from which specimens of 6 by 12-in. cylinders were cut for testing. In general, one cylinder, called Specimen A, was taken near the surface, and others, Specimens B, C, etc., were taken lower down. The depth at which the deepest cylinders were taken was about 10 ft.

Some of the conditions of construction and material have a bearing on the strength tests. On the Marseilles Lock, traveling wall forms of steel, continuous from top to bottom, were employed. Therefore the concrete was built up very rapidly in each section. Bank-run gravel, unwashed, was used entirely. This material is readily obtained in suitable quantity in the Illinois River valley. At the Lockport Lock, the methods and materials were similar to those for the structure at

Marseilles. Construction of the Brandon Road Lock closely resembled that at Lockport except that the gravel came from two or three different pits. At the Starved Rock Lock the methods used were the same, but the material was taken from a different pit. In general, at least four compression tests were made at each depth for each lock. In Table I only the averages for the tests are recorded.

It will be noted that in each instance the strength increases with moderate depth. Some of these increases are quite marked. For deeper specimens, however, the tests are not so conclusive. In the older concretes, at Marseilles and Lockport, the strength increases continuously with depth, showing the benefit of allowing the concrete to set under pressure. The variations are so definite and consistent as to leave no room for question. With the Brandon Road and Starved Rock structures, however, the trends are reversed and the deeper specimens are markedly lower in strength.

TABLE I. AVERAGE OF COMPRESSION TESTS ON OLD CONCRETE AT VARIABLE DEPTHS, ILLINOIS WATERWAY

Strength in Pounds per Square Inch

STRUCTURE	AGE IN YEARS	LOCATION			
		Tests A	Tests B	Tests C	Tests D
Marseilles Lock	10	3,900	5,005	6,366	...
Lockport Lock	7	5,341	5,373	6,025	6,733
Brandon Road Lock	3.5	5,065	6,088	4,892	4,748
Starved Rock Lock	5	5,219	6,136	4,353	4,245

These tests seem to indicate, generally but not always, a tendency toward higher strengths at greater depths.

Our Readers Say—

In Comment on Papers, Society Affairs, and Related Professional Interests

Story About a Covered Bridge

TO THE EDITOR: I was interested in the photographs of covered bridges in the April and the October 1932 issues of CIVIL ENGINEERING; also in the November PROCEEDINGS.

There have been many experiences in connection with these old wooden bridges and many amusing stories concerning them, but I think that one of the funniest incidents I have heard of happened to my grandfather. He had a large fleet of Connestoga wagons operating from Philadelphia and Baltimore, through my home town Poland, in Mahoning County, Ohio, to Cleveland and Detroit. Products of his large broom factory at Poland were shipped east and west. He ordered a load of brooms sent by one of the teamsters, whose name was Sam Halabau, to Pittsburgh, a distance of some 60 miles over the old stage road from Cleveland to Pittsburgh.

This teamster finally arrived at the west bank of the Allegheny River where it was crossed by the 43d Street Bridge, one of those old, long, covered structures. When he approached the entrance to the bridge, he looked through, and the opening at the far end appeared so small he turned around without attempting to cross. Driving all the way back to Poland, he explained to my grandfather that he had arrived safely at the 43d Street Bridge but that it was too small at the far end for him to get through. That was the end of Sam Halabau's career.

E. K. MORSE, M. Am. Soc. C.E.
Engineer Member, Water and Power Resources Board of Pennsylvania

Pittsburgh, Pa.
January 4, 1933

Railroads Deserve Better Treatment

TO THE EDITOR: In discussing the situation of the railroads, which has been reviewed by Elisha Lee in the December number, there are two fundamental points which should be stressed more frequently and more positively. These are: (1) the railways as a nation-wide system of transportation, and (2) the railway system as an investment. It is not sufficiently realized that the railways constitute the only nation-wide, or unit, system of transportation. From almost any one point a person can travel to almost any other point by an unbroken line of railway. He can ship package freight and carload freight in the same way, and he can purchase through tickets covering a journey over several different lines. And although his freight may travel over several railways, its continuous movement is provided for by interchange and transfer facilities. Thus the sender need have no concern for his freight after he has delivered it to the first railroad.

With highway transport, the conditions are very different. The system is composed of a great number of independent concerns operating motor-coach and motor-truck lines. But they constitute a series of separate and largely disconnected units. Even those which connect rarely provide for through routing of either passengers or freight. It may be said that eventually these independent lines will develop into a connected unit system. But it is a condition and not a theory that has to be considered at this time, and there are no indications that a unit highway transport system will be available for many years.

Under such a condition, it seems obvious that the wise and economic policy is to give adequate support to the railway transport system, with its nation-wide network of lines and its universal service. Instead, the railways are subjected to restrictions by Federal, state, and local government authorities, such as are imposed upon no other great industry. In addition, they are continually harassed by shippers, shippers' organizations, local authorities, and others, demanding lower rates, lower fares, increased service, higher taxes, and costly improvements, which last usually benefit the railways little if at all.

All these demands are made without thought or recognition of the railways' need of support in maintaining their great transportation system. The demands are also too often accompanied by denunciation of the railways and their managements, and such proceedings naturally create in the public mind an opinion unfriendly to the railways. The results of such treatment are evident in the financial difficulties, receiverships, passing of dividends, reduction in employees, and other features of the critical railway situation.

It is largely forgotten also that funds for railway operation and development are furnished to a considerable extent by small investors, either directly or through savings banks and other institutions which purchase railroad securities. The decline in value of such securities is creating a serious situation.

The great economies in railway operation that have been effected in the past few years are all that have saved the railways from something approaching disaster, both as a transportation system and as an investment field. But these economies cannot be continued indefinitely. With all allowance for the present and prospective importance of highway transportation facilities, there is evident need of a better, or more reasonable, attitude

towards the railroads on the part of government authorities, commercial interests, and the public generally.

E. E. R. TRATMAN, Assoc. M. Am. Soc. C.E.

Wheaton, Ill.
January 19, 1933

Building Safety Into Automobile Drivers

TO THE EDITOR: A paper in the December issue by J. L. Bauer deals primarily with the relation of the design and construction of highways to the safety of motorists. Possibly a more vital issue is, "Building Safety Into Automobile Drivers." This letter will touch briefly on an analysis that I made of automobile accidents in Mercer County, New Jersey, exclusive of Trenton, during the first ten months of 1932.

As shown in Table I, lack of "safety in drivers" rather than lack of "safety in roads," is the real cause for the enormous number of automobile accidents which occur on the rural highways. Thus the problem of accident prevention becomes one of "human engineering" rather than of "civil engineering." In the 451 reported accidents, 382 persons were injured and 25 killed, and the data show that 47.4 per cent of the persons injured and 39 per cent of the fatalities were thus injured or killed in the cars not causing the accidents.

TABLE I. REASONS FOR ACCIDENT

ITEM	NUMBER OF ACCIDENTS	PERCENTAGE OF TOTAL
Fault of driver	397	88.0
Condition of road or weather	23	5.1
Driver intoxicated to some extent	16	3.6
Car defect, mostly tires	15	3.3
Total	451	100

The primary causes, which are given in order in Table II, were derived from the descriptions of the accidents in the official reports. They definitely show that the human element predominates in motor-vehicle accidents. If the number is to be decreased, a good method would be to inform the public as to the relative value of the primary causes.

TABLE II. PRIMARY CAUSES OF ACCIDENTS

PRIMARY CAUSE	NUMBER OF ACCIDENTS	PERCENTAGE OF TOTAL
Collision at an intersection or driveway	109	24.2
Collision through attempt to pass car ahead	45	10.2
Collision with pedestrian	41	9.0
Driving too close to preceding car	39	8.5
Driving too close to opposite passing car	24	5.3
Leaving, or skidding from, road	24	5.3
Making turn at curve	20	4.3
On wrong side of road	17	3.8
Driver intoxicated to some extent	16	3.5
Car or tire failure	15	3.3
Percentage of 451 accidents	...	77.4

Accidents cannot be blamed on the weather as 72.5 per cent occurred during "clear" weather. As shown in Table III, it is the kind of driving rather than the kind of road that causes most collisions.

TABLE III. LOCATION AS AFFECTING ACCIDENTS

LOCATION	NUMBER OF ACCIDENTS	PERCENTAGE OF TOTAL
On straight or open roads	257	57.0
At street or road intersections	134	29.7
At curves on roads	35	7.8
At private driveway entrances	25	5.5
At top of hills	0	0.0

Most accidents occur by collision between vehicles, as seen in Table IV, and few happen because of fixed objects at the sides of the roads.

TABLE IV. OBJECTS CAUSING ACCIDENTS

OBJECT	NUMBER OF ACCIDENTS	PERCENTAGE OF TOTAL
Between vehicles	336	74.6
With pedestrians	41	9.0
With fixed object	37	8.2
No object involved	37	8.2

There can be no question but that the controlling influence in decreasing the accident rate will be educational rather than regulatory in character. A driver studying the relative value of the ten primary causes of accidents, as shown in Table II, would be strongly impressed, as they involve 77.4 per cent of the accidents that occurred in the county. Proper educational propaganda on the primary causes of automobile accidents undoubtedly will produce more careful drivers.

ARTHUR RICHARDS, M. Am. Soc. C.E.

Trenton, N.J.
January 3, 1933

Stirrup Spacing for Other Than Simple Concrete Beams

DEAR SIR: The method for determining the spacing of stirrups in reinforced concrete beams, on page 6 of the January issue, is stated by the author, Mr. Burmister, to be a simplification of the present method. In the process of simplification, Mr. Burmister has restricted the application of his method for Case 1 to uniformly loaded beams in which the plane of zero shear is at the center of the span or, in other words, to beams with free supports or to those restrained equally at each support. A proper analysis of beams in reinforced concrete structures reveals comparatively few beams of either type.

The scope of the method would be greatly enlarged by substituting for $\frac{L}{2}$ in Equation 1 *a* the value $\frac{V'}{w}$, in which w is the uniform load per lineal foot. The treatment of Cases 2 and 3 is too restricted to be of value to the designer. For Case 2, Mr. Burmister assumes that the section where the computed shearing stress is zero is at the center of the beam, and also that the total shear at the support V' obtains simultaneously with a shearing stress at the center equal to one-quarter of the total shearing resistance required at either end of the span. I doubt that Section 122 of the Report of the Joint Committee on Standard Specifications for Concrete and Reinforced Concrete is intended to convey this meaning. Case 3 is limited to the special cases of beams with concentrations at the center, in which V'' is greater than V.

Incidentally, I want to call attention to the following errors: (1) In the formula, $\frac{V}{bjd} = v'$, the large V should read V'; (2) in Equations 3*b* and 3*c*, the value v should read v'.

R. L. BERTIN, M. Am. Soc. C.E.
Chief Engineer, White Construction Company

New York, N.Y.
February 3, 1933

Deflection of Reinforced Concrete Beams Under Load

DEAR SIR: Having read the paper, "Deflection in Reinforced Concrete Beams," by Mr. Burmister in the October issue of CIVIL ENGINEERING, I attempted to check, by means of the formula suggested in his article, the deflection of certain small reinforced concrete beams used for classroom demonstration work at the University of Wisconsin.

These beams are designed to show students how reinforced concrete beams deflect under load, and how the steel and concrete mutually serve to carry the load. Selecting a typical example, tested recently, with the following characteristics, b = 6.25 in., d = 6.6 in., A_s = 0.393 sq in., p = 0.00953, E_c = 3,600,000 lb per sq in. (by test on concrete cylinders), and n = 8.33, it was found, with a 96-in. span and third-point loading, to deflect with practically a straight line relationship to a load of 2,100 lb and a deflection of 0.036 in. With further loading, the load-deflection curve extended as another straight line to a deflection of 0.3 in. and a load of 6,000 lb, at which load the beam failed. For this beam, employing the usual formulas, k = 0.328, j = 0.891, and

f_s = 16,000 lb per sq in. at a load of 2,320 lb and 18,000 lb per sq in. at a load of 2,610 lb.

Applying Mr. Burmister's formula, $\Delta = \frac{Cf_sL^2}{E_cd\,[2(1-k)]}$, we find a predicted deflection of 0.118 in. at f_s = 16,000 lb per sq in. and of 0.133 in. at f_s = 18,000 lb per sq in., the fiber stresses in the steel being calculated by the usual formulas. These deflections compare with the actual deflections of 0.052 in. and 0.071 in., respectively. For these loads and stresses, the formula gives deflections that are approximately twice too large, at least, for rapid loading conditions. At a load of 6,000 lb (f_s = 41,400 lb per sq in.), the deflection as calculated from the formula agrees very closely with the actual deflection. This is scarcely a practical case, however, as the beam is starting to fail.

Applying Formula 3 of Turneaure and Maurer, found on page 154 of *Principles of Reinforced Concrete Construction*, different results are obtained. The formula, $D = \frac{C'\alpha WL^3}{E_cbd^3}$, predicts a deflection of 0.055 in. at a load of 2,320 lb (f_s = 16,000 lb per sq in.) and 0.062 in. at a load of 2,610 lb (f_s = 18,000 lb per sq in.). These compare very well with the observed deflections of 0.052 in. and 0.071 in., respectively. As the load at failure, 6,000 lb, is approached, the formula gives deflections that are too small.

These data are for only one of a series of small and intentionally under-reinforced concrete beams, but many other examples are given by Turneaure and Maurer. Still others may be found by applying the two formulas to the results of various tests where the beams were rapidly loaded. Long-time loading will produce deflections in excess of those found under more rapid loading. It would be interesting to know whether the data upon which the presentation of Mr. Burmister's formula is based represent long-time loading and whether the fiber stresses in the steel were calculated by the usual formulas or were determined from a measurement of the strains in the steel. If the formula gives satisfactory values for long-time loading or if it could be modified by suitable factors for rapid loading, it would be a type of formula that could be used quickly and easily in the design of a reinforced concrete beam, where the deflection is of importance.

L. O. HANSON, Jun. Am. Soc. C.E.
Instructor in Mechanics
University of Wisconsin

Madison, Wis.
January 6, 1933

Computations of Stirrup Spacing

DEAR SIR: The method of spacing vertical stirrups in reinforced concrete beams, as described in Mr. Burmister's commendable article in the January issue, has many points of interest, but is hardly new. An identical table of coefficients for 20 stirrups is given by Taylor and Thompson, and a similar table for groups of even spacing is presented in the *Handbook of Reinforced Concrete Building Construction*, published by the American Concrete Institute. This method has proved too cumbersome for practical use, as complications have resulted from first computing the theoretical number of stirrups required and then spreading these out to conform to the required spacing.

It seems to have escaped general notice that the ordinate at any point in the shear diagram is inversely proportional to the stirrup spacing required. Given this relation, a very simple and accurate solution of the problem, requiring no charts, coefficients, or other artificial aids, except the slide rule, is therefore possible. After computing the distance X', it is only necessary to compute the spacing at the support from the usual formula, $s = \frac{16{,}000\,A_v}{(v'-v)b'}$, and the rest of the spacing can be read from the slide rule with the aid of some simple mental subtractions.

Solving the problem as given in Mr. Burmister's article, transform Equation 1*b* for easier solution by the slide rule to read as follows: $X' = \frac{\frac{2L}{3}(v'-v)}{v}$. Substitute the values given and solve for X'. Thus $X' = \frac{96 \times 53}{93} = 54.7$ in. (say 55 in.). Spacing at the support, using one-quarter round U-stirrups, will be $s = \frac{1{,}570}{53 \times 8} = 3.7$ in. Multiply s as found by this procedure by X' on the slide rule and leave the hair line of the runner set at the product, which need not be read, as this is only an incidental step in the operation. Now subtracting 3.7 from X' (or 55 − 3.7), set 51.3 under the hair line and read the quotient 3.98 in., which is the theoretical spacing at the next stirrup, and similarly for the succeeding spacings until the maximum allowable is reached. In practice, these spacings would be rounded off and grouped as follows: one at 3½ in.; three at 4½ in.; three at 6 in.; and two at 8½ in. If this grouping is kept in mind at the beginning of the computations, the number of operations of the slide rule is reduced and the result is as accurate as the nature of the problem requires.

The solution for Case 3 in Mr. Burmister's article can be undertaken in the same manner after solving Equation 7 for X''. In his Fig. 3, V'' is incorrectly shown. The lower arrow point on the dimension line should reach the base of the figure, as is apparent in his solution. Ordinarily in cases of this kind, where the slope of the shear diagram is small, the spacing is computed at each end of the trapezoid and the remainder adjusted by inspection.

It will be noted that in the solution just described, I have placed the first stirrup at the full theoretical distance from the support, as I believe that this is in accordance with the assumptions of the theory. If other designers take exception to this, the first stirrup may be placed to suit any regulation or individual notion, and the remainder of the computations will be modified accordingly.

I do not believe in either the theory or practice of using vertical stirrups for resisting diagonal tension and am at a loss to understand their continued use in the face of widespread analyses and tests demonstrating their ineffectiveness.

Bristol, Va.
February 3, 1933

G. M. STONE, M. AM. SOC. C.E.
Architect and Engineer
G. M. and G. C. Stone

Development of Columbia River Uneconomic

TO THE EDITOR: In his article, "Improvement of the Columbia River," Colonel Robins has invited discussion of an economic problem both national and international in character. Should we open new lands to cultivation or give major consideration to the protection of existing farm investments which are part of our domestic credit status? Should we invest in water power development with the idea of exporting electrochemical products?

For 300 years the United States was a debtor nation with a small capital structure. During this time it learned that, apart from the transfer of title to investments, there is only one way in which debts can be paid and that is by men at work. We worked and delivered our surplus products to our foreign creditors. Now we have no foreign creditors, and in 1919 we became the world's greatest creditor. Our debtors have other debtors from whom they prefer to buy as an affair of sound business. Since their debtors have a lower standard of living than we, they will sell at prices lower than ours. This is the reason for the decline in our agricultural exports through credit operations, accentuated by the growing competitive power of those who are in debt to our debtors. It would be folly to expect European countries to reduce tariffs in order to favor us, their creditors, at the expense of themselves and their debtors.

Except for cotton and hog products, we are practically through exporting agricultural products to Europe. If we made an effort, we could export some products to the tropical regions south of us, but we will not make the necessary effort until conditions force us to do so. Because of our domestic facilities for the transportation and conservation of food, there is no need for additional farm land in the United States except to serve a few groups of self-supporting agrarians.

The dedication of water power, or anything else, for use in the manufacture of electrochemical products for export is hazardous

in a financial sense. All the leading industrial countries are developing their own nitrogen plants for purposes of defense in time of war, and meanwhile will use these plants in the manufacture of fertilizer and other products. We have no need for more fertilizer plants. Aside from installations in this country, Chile owes our nationals enough to supply us with nitrogen for the next 50 years, and there are other sources among our debtors. Since our national capital investments are generally in excess of our needs, returns cannot be earned on them. Before extending investment we must devote more of our earnings to dividends, writing off obsolescence and rate bases and directing funds into the channels of consumption rather than of investment and taxation. This itself will reduce the interest rate and put future investments on a sounder basis.

VERNE L. HAVENS, M. Am. Soc. C.E.
Consulting Engineer

New York, N.Y.
January 29, 1933

Texas Section Bond Form Unworkable

TO THE EDITOR: The new contract bond form and supporting arguments appearing in the February number may seem plausible to some of our members, but to an engineer familiar with the surety business, the form offered by the Texas Section is unworkable. The proponents offer it as a substitute for prequalification, but its use would tend to keep the irresponsible contractor in the business, for a time at least, as under it all his obligations would be guaranteed; therefore, he would have unlimited credit. Many reputable contractors say that the guaranteeing of any bills is an extension of "false credit," which is against the best interests of the industry.

The contractor signing the proposed new form as principal would be forced to pay, or reimburse the surety, for all the unpaid bills or obligations of any subcontractor to the *n*th degree for all such things as bank loans, contractor's plant, etc. In the apparent desire of the proponents to deal strictly with the surety, they have overlooked the fact that all the obligations imposed upon the surety are first placed upon the contractor as principal in the bond, and that very few of the careful and responsible contractors, in whose interests it is alleged the form has been prepared, would care to obligate themselves for bills of this class so far removed from their own operations.

The form says that "all of whom" (meaning the miscellaneous class of claimants there indicated) "shall have the right to sue upon this bond in the penal sum." Thus the penal sum can be multiplied by as many times as there are claimants. The surety would have a wide-open liability of an unknown amount. Further, "the surety assumes full responsibility for the fidelity of the contractor in applying such payments to the liquidation of all claims based on indebtedness." In some cases, this would mean joint control by the surety over the disbursements of the contract payments with no payment permitted to the contractor for his own use until all incurred indebtedness had been paid and, perhaps, not until the work had been accepted and evidence furnished that all debts had been discharged. Such supervision would be costly and obnoxious to both the surety and the contractor.

The form provides that the surety shall waive all defenses to all claims made prior to the completion of the contract, no matter how grossly unjust any such claim might be. This is not only an attempt to nullify laws under which the surety might have redress but it is inherently unfair. No prudent contractor would sign a contract which made him waive all his legal rights. Why should a surety sign a bond with such a waiver?

The owner really pays the bond premium, and the new form with the greatly increased hazards to the surety would surely call for an increase of two, three, or more times the present charge in the event that the bond form came into general use. The article recognizes that there would naturally be a higher premium charge for such a bond than for the usual form, and it suggests that a sliding scale of rates could be applied to contractors according to their assumed experience and responsibility. This suggestion offers a false hope. Elaborate consideration was given to it for many years by all the leading surety companies, before it was discarded as impractical. In various states any such discrimination between applicants of the same general class would be contrary to law.

This Texas form has been offered to sureties a few times during recent months, and some bonds may have been executed on it. However, most of the surety companies now have copies of the form and it is believed that a large number of them would not authorize it for any premium that might be offered. It is uneconomic to the owner whether public or private; it is unfair to the reputable contractor and his surety and, lastly, assuming it could be obtained, it would not eliminate the irresponsible bidder. It is not workable.

EDWARD W. BUSH, M. AM. SOC. C.E.
Engineer, Surety Dept., Aetna Casualty and Surety Company

Hartford, Conn.
February 6, 1933

Calculating Vertical Curves by Slide Rule

TO THE EDITOR: There are several methods of solving problems of vertical curves, one of which is that given by C. O. Carey, M. Am. Soc. C.E., on page 34 of the January issue. All of them involve a certain amount of mathematical manipulation which adds a great deal to the work of computing grade elevations, especially in the field.

The slide-rule method is very simple and fast, and practically eliminates the chance of error. The application of this method is as follows:

1. To find the middle ordinate (see Fig. 1), multiply the length of the vertical curve in stations by one-eighth the algebraic difference of the rates of grade.
2. To find the intermediate ordinates, set the indicator on the

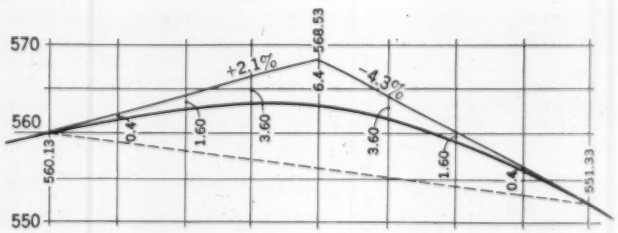

FIG. 1. SLIDE-RULE SOLUTION FOR VERTICAL CURVE

middle ordinate on Scale *A* of a slide rule, opposite which set one-half the length of the curve on Scale *C*. Move the indicator along Scale *C* to the distance required on the curve, then read the intermediate ordinate on Scale *A*. These values applied to the elevation of the tangents give the vertical curve elevations required. The adaptation of the slide-rule method to the problem given by Mr. Carey is readily seen by reference to the accompanying Fig. 1.

BURTON G. DWYRE, Assoc. M. Am. Soc. C.E.
County Engineer, Grant County

Silver City, N.M.
February 6, 1933

Rapid Solution for Vertical Curves

TO THE EDITOR: The material presented in the article, "Calculating Vertical Curves by First and Second Differences," by Professor Carey, in the January issue, is worthy of comment. A parabola may be defined as a curve whose rate of change of slope is a constant. This follows, of course, from the fact that the second derivative is constant, as shown by Professor Carey's

Equation 2. This fact has long been known to railroad and highway engineers, and the term "rate of change" is in common use.

It is evident that the terms, "rate of change" and "second difference," are synonymous and that the quantity is the change in slope from chord to chord of equal length. It therefore follows that the "first differences" are the slopes of these respective chords.

The rate of change is found directly by dividing the total change of grade by the adopted length of curve. Thus:

$$\text{Rate of change} = \frac{+2.10 - (-4.30)}{8} = 0.80$$

There may be some disagreement as to the sign of this quantity but, employing the usual nomenclature, it is positive for summits and negative for sags and is always subtracted algebraically.

The change of slope from a tangent to a chord is one-half the change from chord to chord and therefore is equal to one-half the rate of change. Consequently, the first "first difference" is most easily found by subtracting one-half the rate of change from the entering grade, as follows: $+2.10 - 0.40 = +1.70$. Similarly, if one-half of the rate of change is subtracted from the last "first difference," the result is the departing grade, and this constitutes a check on the computations, or $-3.90 - 0.40 = -4.30$. Each intervening "first difference" is derived from the preceding by subtracting the constant "second difference," or rate of change, as indicated in Professor Carey's article.

This method of computing vertical curves, which is often termed the "rate of change method," is by no means new. It is to be found in detail in Pickel's and Wiley's *Route Surveying*, also in Ives' *Highway Curves*, and more or less completely in the field manuals of Allen, Searles, and others.

Incidentally, this method is quite convenient on long curves with stakes 100 ft apart, since the rate of change and first differences are all percentages of grade. Where stakes are closer together, these cease to be percentages of grade, since the rise or fall in feet in the distance between stakes must be used. Under these conditions the method of offsets from tangent elevations is probably the fastest and most convenient and the least susceptible to error. Where a calculator of the Monroe type is available, this latter method is probably the best in all cases.

C. C. WILEY, M. Am. Soc. C.E.
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Urbana, Ill.
February 2, 1933

Short Methods of Extracting Roots

TO THE EDITOR: In the December issue, Mr. Black describes a useful method of extracting square roots to the fourth significant figure by means of a slide rule. This method and a similar one for extracting cube roots were outlined by me in *Engineering News* for June 14, 1906, page 661. Both methods are simple, and when ordinary tables of squares and cubes are available they can be used readily for extracting roots of large or small numbers rapidly and with a high degree of accuracy, by the methods that follow, with the additional use of only an ordinary slide rule for making divisions.

For square roots the problem is to find the value of z in the formula: $n + z = \sqrt{a}$, where a is the number whose root is wanted, and n is the largest integer whose square is less than a, taken from the table of squares. By means of the binomial theorem, $z = \frac{a - n^2}{2n + z}$, without error. Here n^2 is taken from the table of squares, and as a first step z is dropped from the denominator in order to secure an approximate quotient. The resulting value is then used as z in the denominator for obtaining the final value of z on the left-hand side of the equation. Then $n + z$ is the required root.

The square root of 19,137.54 is found by the operations just described (with a slide rule) to be 138.3383. Here z is found to be 0.3383 and n is 138. The true root is 138.3385.

For cube roots the problem is to find the value of z in the formula: $n + z = \sqrt[3]{a}$. The equation for z is: $z = \frac{{}^1/_3\left(\frac{a}{n} - n^2\right)}{n + z}$. Or, more accurately, $z = \frac{a - n^3}{3(n + 0.5z)^2}$. Here n^2 (or n^3) is taken from the table, and the steps to obtain the final value of z are the same as given for square roots. Then $n + z$ is the desired cube root. The cube root of 19,137,540 by the first equation (using a slide rule) is found to be 267.1577. The true root is 267.1578.

For cube roots the equations for z give somewhat less accurate results for values of a below about 10. This does not occur if the table is used only above the limit of $n = 100$ and the proper position of the decimal point is observed.

When only a slide rule is available, similar methods are followed in both cases, except that the value of n is assumed conveniently. For values of a below about 10, the roots are obtained somewhat more accurately with the slide rule if the nearer value of n is chosen. When the higher value of n is chosen, the sign before z must be made negative throughout, and the numerator must be considered positive in all cases. The root is then $n - z$.

The principal advantage in using these methods for extracting roots lies in the ability to secure accuracy much beyond that which can be obtained with the use of the most extensive tables of logarithms, and in its utility entirely without logarithms. With only a slide rule the methods are convenient for extracting the lower roots rapidly. The higher roots may be extracted with considerable accuracy also by this means, when supplemented by some preliminary work in long division.

HARRY E. ECKLES, M. Am. Soc. C.E.

Chicago, Ill.
February 7, 1933

New York Subway Development Reviewed

TO THE EDITOR: The article by A. I. Raisman on "Advances in Subway Design and Equipment," in the January issue, is of particular interest to those who may be connected with work of this character, and is a valuable record of progress. The article states that at certain special points on down grades, the normal 3 per cent rate limit has been exceeded. Actually it is the down grade, and not the up grade, that controls the train capacity of a subway. On the up grades, the force of gravity assists the brakes in stopping the train and shortens the space interval necessary for safety. On down grades the reverse is true, and for a given speed the train interval must be longer, and hence the train capacity is decreased.

Our investigations have shown that at about a 3 per cent grade the speed could be so reduced as to permit the same time interval (train capacity) as on the level, but above the 3 per cent grade the train spacing must be so increased that it will lessen the capacity. A 3 per cent grade has a train capacity approximately 25 per cent greater than a 5 per cent grade, and the heavier grade was permitted only where it was necessary to use the existing bridges over the river. This took into account the possibility of replacing the bridge by a tunnel of lighter grade, if future traffic would justify that expense.

The success of the late William Barclay Parsons, Hon. M. Am. Soc. C.E., in the introduction of subways into New York City did not depend upon their detail plans, except in the matter of economy, but was due to his great tact and perseverance in overcoming political and financial obstacles. He was fortunate in his selection of St. John Clarke, one of the ablest men of his day, as his structural assistant. Their adoption of the Budapest type of construction, which had been completed some two years earlier, has been amply justified by subsequent experience. The kiosks, considered rather unsightly in New York, were, with the surrounding architecture of Andrassy Street, features of adornment in Budapest, where the beautiful castle on the Buda side of the Danube, the Parliament buildings on the Pest side, and the choice variety of bridges across the river, make the city one of the jewels of Europe.

The Public Service Commission of 1907, for which I was Chief Engineer, took up the study of increased comfort and earning power of the subways. The length of trains was increased to 10 cars, with a width of 10 ft each and additional side doors. The cars were of the height and length of the standard railroad coach. Electric train signals were substituted for the bell cord, and turnstiles were proposed and later introduced.

In order to provide a cooler subway for summer travel, all bituminous waterproofing was omitted above ground-water level, and 6 in. of broken stone was spread over the roof to ensure drainage. Concrete of a 1:2:4 proportion, properly mixed and puddled solid in place, was found to be practically waterproof. The iron columns between tracks, a source of danger in the case of train derailments, were replaced by reinforced concrete partition walls with occasional openings, to ensure proper ventilation by the piston action of the trains. The parallel-bar ventilator gratings in the sidewalks, so objectionable to wearers of thin-soled shoes, were modified by adding crossbracing. The bottom of the subway was designed so that track ties embedded in concrete could be used if the operator so desired.

The express tracks carry about 80 per cent of the earning revenue, and it was proposed to institute reservoir, or multiple-track, express stations, thus doubling their capacity. The earning power of the subways was more than doubled by this commission.

HENRY B. SEAMAN, M. Am. Soc. C.E.
Consulting Engineer

Brooklyn, N.Y.
February 1, 1933

Increased Public Works Uneconomic

DEAR SIR: The three papers in the December issue, advocating public works construction to aid in restoring normalcy to our economic life, expound in some detail the program sponsored last year by our Society—a program that I believe offers but little hope.

In his paper, Mr. Hogan says that the construction of a great bridge may lead to the development of a new district and benefit a large population. If it does, it is self-liquidating in fact if not in form. On the other hand, is it expedient to borrow on public account for the construction of a bridge that is not used and does not materially benefit the public—an Ambassador Bridge, for example—merely to provide work? Public works or private works are sound and justified only when they benefit their owners, at least to the extent of their cost. Public debt is not warranted for expenditure on intangible or luxury benefits such as parks—let them be paid for currently. Public obligations and income are already out of adjustment.

It is logical to look to the artificial expansion of construction to provide work, and it is equally logical to expand the luxury trades. We cannot sanely promote the manufacture and distribution of luxuries on credit, either public or private. Such industry and commerce must be paid for. We have just completed two decades of frenzied business activity by expanding debts in all directions. That period is over, and we must forget that method of living. Credits are insidious and unnecessary.

A system of enforced reserves to stabilize industry and to finance public works is proposed by Mr. McDonald. The nature of the business cycle and of credit defeats this purpose. Periods of prosperity are supported by pyramiding expansion, during which the capital industries provide part of the buying power or markets for the expanding industries. Since competition finally kills the expansion, it destroys this part of the market and causes the depression, the extent of which is determined by the extent of the expansion and debts. If the enforced reserves accumulated by a firm cannot be expanded in plant enlargement this will certainly retard the expansion of that firm but not of the industry in the hands of competing firms. Furthermore, such so-called liquid reserves are not like talents that can be buried in the earth and dug up later to pay for public works in the succeeding depression. They are either invested directly or deposited in a bank which in turn invests them currently, and such reserves are therefore not available for investment later on.

However, there is no point in preserving funds for public works. Normally, credits are available or can be generated for any paying or self-liquidating enterprise, public or private. We are in a period of stagnation because it is impossible to develop paying enterprises, public or private, in normal quantity; there is plenty of idle credit now. We cannot develop paying enterprises because our pecuniary unit, the dollar, has recently doubled in value, destroying the equity of contracts, debts, taxes, etc.

It is necessary to remedy this dislocation of our financial situation before normal employment can be provided. Conceive of a situation in which a constructor, who has a contract signed to build a dam 600 ft long and 100 ft high, finds before he executes the contract that the standard yard in the archives of the Bureau of Standards is doubled in length, though still called a yard, and the constructor must build the dam according to the new standard. Could he get credit? That is how we are fixed today, and it is as proper for us as for any other group to suggest a solution to the new administration.

E. S. MARTIN, Assoc. M. Am. Soc. C.E.
Secretary-Treasurer, James A. Wickett, Ltd.

Toronto, Ont., Canada
January 9, 1933

Study of Bridge Model

TO THE EDITOR: Professor Finlay's paper on "Deck Participation in Concrete Arch Bridges," in the November issue, is of special interest to me as I recently used the same method in a study of a similar problem at the Johns Hopkins University.

The model representing one span of the Yadkin River Bridge, was of celluloid 0.08 in. in thickness, to a scale of 1 in. equals 5 ft. Dimensions of the actual structure were as follows: clear span, 146 ft 3 in.; rise, 28 ft 3 in.; depth of rib at crown, 2 ft 6 in.; at springing, 4 ft 6 in.; and width of rib, 4 ft 0 in. The span was divided into 12 panels, with expansion joints in the deck at the quarter points.

A comparison of analyses was made under two conditions; first, with expansion joints; and second, without joints. This showed, for the second condition, material reduction of both moment and thrust influence line ordinates and existence of negative ordinates of the thrust influence lines at sections near the crown. Changes in these functions at the springing were slight.

A comparison of the rigid structure (no expansion joints) with the free arch rib gave interesting results. Analyses were made at several sections of the rib from crown to springing. At each section the ordinates for moment and shear were less in the rigid structure than in the free rib. However, in the rigid structure the maximum ordinates for thrust at sections near the springing showed an increase over those for the free rib and also showed small negative branches to the curves at the far end. A stress comparison for dead loads plus live loads (the live load was 1,125 lb per ft of span) showed a maximum of 500 lb per sq in. in the rigid structure, and a minimum of 500 lb per sq in. in the free rib. This would indicate a possible saving of material in the rib, but this disappears when the result of temperature change is observed.

The method used to investigate temperature effects was more experimental than that described by Professor Finlay.

First, the position of the point of application, or "neutral point," of the horizontal force was obtained practically as Professor Finlay describes. Next the amount of this force required to produce the predetermined horizontal motion in the model corresponding to the temperature variation was determined by trial. By using this force to deflect a model cantilever beam of known properties, the force on the actual structure needed to produce the correct horizontal movement of the abutment could be calculated, since the deflection of the cantilever was known. Of course, moments are caused by temperature variation in both deck and rib. These were also obtained experimentally. With these data it was possible to calculate the temperature thrust in the rib at any desired section.

Results of this investigation showed that the increased temperature thrusts of the rigid structure eliminated the chance of reducing the material used in the arch rib. Although expansion joints would alleviate the burden of temperature thrusts, they would cause an increase in moments and thrusts caused by live and dead loads.

KARL E. ERTHAL, Jun. Am. Soc. C.E.

Baltimore, Md.
January 21, 1933

Chemical Processes in Water Supply

DEAR SIR: From the paper entitled "Water Supply of Delaware County Menaced" by Harry M. Freeburn, in the December issue, it appears that, at least in one section of the country, we have approached the point where, in effect, a community is using diluted sewage, after it has been treated, for its domestic water supply. How else can one describe the waters of the Delaware River nine miles below Philadelphia, which discharges its sewage directly into the river? A considerable part of this water receives no treatment, and some of it is given partial treatment only. That this condition is being approached in many other large centers of population is a well recognized fact. Thus many communities are already faced with the problem of going great distances in order to obtain, if possible, upland sources of water supply, and of expending huge sums of money for the development and construction of a water-supply system.

The City of New York presents a striking instance of a community, where no sooner is one water-supply development constructed at tremendous cost, than there is an immediate demand for additional supplies, always at greater distances from the city and obtainable by constantly mounting expenditures of money. The greater water-supply undertakings in New Jersey today, necessitated by the requirements of the larger cities whose adjacent bodies of water present unsuitable sanitary conditions, illustrate another factor contributing to the tremendous costs of obtaining new sources of water supply under such conditions. In this instance, the creation of huge storage reservoirs will result in wiping out numerous towns and villages. The inhabitants of such areas are apparently not willing to step aside and let the results of their work as well as that of the generations preceding them, be swept away without severe legal battle, all of which results in long delays and mounting costs.

The experience of the City of Chester, in attempting to deliver to the people water so heavily charged with sewage that at times a B. coli index of over 601,000 per 100 cc is found, brings up the question of whether or not the time is coming when, in these large centers of population, further advances may not be made in the art of sewage purification, so as to render the effluent wholly sterile and potable. This would pave the way for the completion of the cycle of utilizing treated sewage directly as a source of water supply.

The Chester water-purification plant might really be considered an experimental sewage-treatment works for treating a dilute sewage, such as the river at that point is, and transforming it into a water supply. Furthermore, it must be recognized that the Chester plant has met with no uncertain success in handling this difficult problem, and the effluent obtained from the chemical process of treating a diluted sewage is being successfully used as a potable water supply, at a cost much below that at which an upland supply could be obtained.

The future trend of sewage purification is certainly toward the increased use of chemical processes as against present biological methods of treatment, and with the adoption of chemical methods a more scientific control of results will be possible. In most extreme cases, this treatment might be so extended that the effluent could be used directly for water-supply purposes. Thus the problem of additional supply would be limited solely to that of obtaining a sufficient quantity for making up losses due to leakage, evaporation, and other waste.

ALEXANDER POTTER, M. Am. Soc. C.E.
Consulting Engineer

New York, N.Y.
January 12, 1933

Pile-Driver Blows and Pile-Pulling Resistance

TO THE EDITOR: The data presented in "Holding Down Power of Concrete Piles," by Messrs. Gregory, Allton, and Blodgett, in the February issue of CIVIL ENGINEERING, bring home to me vivid recollections of experiences I have had.

Some years ago, on a large foundation job, I frequently observed that if the driving were suspended overnight upon a pile which was going in at the rate of several inches per blow, the same pile, upon resumption of driving in the morning, would move only a small fraction of an inch under the first few blows. Later, when the frictional resistance built up overnight had been broken down by the movement due to the first few blows, the pile would penetrate at about the same rate observed before suspension of driving.

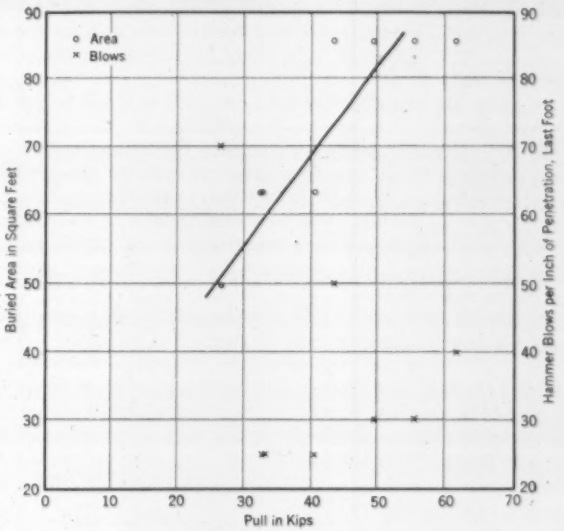

FIG. 1. HAMMER BLOWS NOT A MEASURE OF PILE-PULLING RESISTANCE

This is evidence of the fact that friction plays a far more important rôle in producing pile-bearing capacity than does the resistance of the soil to penetration by the tip, at least in the ordinary pile.

If this is so, it must be apparent that any formula for bearing value, which depends upon rate of penetration—such, for example, as the commonly used $b = \frac{2\,wh}{s+1}$ —is illogical, since it disregards the widely varying condition of the friction during driving and after.

How consistently resistance to pulling out varies with imbedded area and how inconsistently it varies with the penetration can be seen in the accompanying diagram, Fig. 1, which has been plotted from the data presented in the article by Messrs. Gregory, Allton, and Blodgett.

J. TRUEMAN THOMPSON, M. Am. Soc. C.E.
Professor of Civil Engineering
The Johns Hopkins University

Baltimore, Md.
February 6, 1933

City Planning Economically Feasible

DEAR SIR: The papers by Messrs. Arneson and Black, published under the heading of "The Practical City Plan" in the December issue, have touched only incidentally upon the reasons why city planning is a good investment for a municipality. Many laymen are unfortunately still apt to think of it as a luxury, that is all right when money is plentiful but which can be dispensed with when economies are in order. As a result, not only city planning but also city surveying and mapping, which provide the groundwork for planning, are now in a precarious situation in many municipalities and probably will continue to be so for the next year or more. There is tremendous pressure to eliminate, or to cut down to insufficient amounts, the proportions of municipal budgets allotted for these purposes, and I think it behooves all civil engineers to preach the gospel of the financial soundness of these two activities on any city budget.

This can be done on three principal grounds. First, as public improvement projects are being pushed ahead throughout the country to provide much needed employment, it is essential that their design be based on adequate surveys and proper plans for the future development of the municipalities within which they are located. Unless this can be done, the advisability of proceeding with large projects is seriously open to question. Therefore, it may be claimed that only by the continuation, and even acceleration, of mapping and planning activities can it be guaranteed that such public work expenditures will not be largely wasted but will supply needed and permanent improvements.

Second, it should be emphasized that there are many indirect financial savings that will result from a properly prepared city plan. For example, the adoption of a plan will avoid excessive costs for carrying out improvements in the future, as new developments will take place in accordance with the plan rather than in conflict with it. This influence may be felt even without the official adoption of the plan, if it is sound enough to arouse general public approval.

Third, there are many features of a city plan that can be put into effect through legislation alone and neither involve any immediate expense to the general taxpayer nor commit the municipality to any future expense. These include zoning restrictions, the establishment of setback lines, and the adoption of official map lines that will automatically prohibit the construction of new buildings on areas that will later be required for streets or for street-widening purposes, all of which aims toward the maintenance and promotion of amenities and values.

These three ways in which city planning will result in substantial savings to municipalities may well be stressed at this time. Such a procedure will help to bring about a more general realization of the fact that the actual cost of city planning is a very small percentage of the cost of present and future construction, and will probably be repaid many times over in the direct and indirect financial savings that it will bring the municipality.

HAROLD M. LEWIS, M. Am. Soc. C.E.
Engineer, Regional Plan Association, Inc.

New York, N.Y.
February 1, 1933

Asphalt-Impregnated Concrete Valuable

TO THE EDITOR: It was with great interest that I read Oren Reed's article, "Preventing the Disintegration of Dams," in the January issue. He has without doubt given much thought and study to this very interesting and important subject. A few years ago it was thought that the advance in the method of manufacturing modern cement ensured a material that would withstand the ravages of nature indefinitely. As time passed, however, it was discovered that the material had its limitations.

Defects first were noticed in concrete surfaces exposed to extreme changes of temperature and subjected to frost. Such defects were most marked where the concrete was exposed to moisture. Then alkali soils were found to corrode the surfaces and corners of concrete masses. Also, building floors subjected to acids, septic tanks, and the walls of sewage disposal plants showed weaknesses, and later the action of sea water on concrete gave cause for anxiety.

The development of reinforced concrete and its utilization for nearly every class of construction revealed the seriousness of these defects in concrete and brought to light others of a still more serious nature that, in many cases, destroyed the structure from within more quickly than did the disintegration of the concrete from without. The moisture entering the surface oxidizes the steel. The rust expands and breaks off the concrete covering and exposes the steel to the moisture and air.

Obviously the remedy is to prevent the entrance of this moisture. Some have advocated making a dense concrete, rich in cement; others, a cement of special quality. But the practical engineer responsible for large construction projects, especially of reinforced concrete structures, knows that it is not practical to prevent the entrance of moisture. It is not possible to construct a large structure of uniform density in which the concrete itself is watertight. Cracks due to expansion and contraction during setting, or to temperature changes occurring later, cannot be prevented.

In the practical manufacture of concrete, there is generally an excess of water beyond that required to give it workability and hydrate the cement. This excess of water has to dry out of the concrete. If excess moisture can get out, it is reasonable to assume that moisture can get in.

I agree with Mr. Reed that hardeners added to the concrete leave a surface more inclined to crack, and further it is my experience that every kind of coating that can be applied to the surface will in time peel off. Granite or other suitable stone has been used to advantage, but it is costly and has its limitations. Mr. Reed's final conclusion is correct, "if the concrete is made and placed in such a way as to avoid the percolation of water," but my experience has brought me to the very definite conclusion that this cannot be done. The solution not specifically referred to by Mr. Reed lies in the use of asphalt-impregnated concrete. Asphalt-impregnated concrete has been successfully used for piles in sea water and for the facing of concrete structures that must be protected.

J. W. B. BLACKMAN, M. Am. Soc. C.E.
President, Pan-Pacific Piling and Construction Company

Wilmington, Calif.
January 19, 1933

Designing Footings by Diagram

TO THE EDITOR: The accompanying diagram for designing foundation footings, Fig. 1, is based on the equations in Preston M. Geren's article, "Designing Footings by Charts," in the October number. This alignment diagram will give more readily and as precisely the values that may be found by means of the chart in his article.

The equations used in constructing the diagram are as follows: $d = 0.0264\sqrt{P}$; $b = \sqrt{\frac{P}{W}}$; and $A_s = 0.00109b\sqrt{P}$, these symbols being the same as those in Mr. Geren's article.

The following problem illustrates the use of the diagram. Find

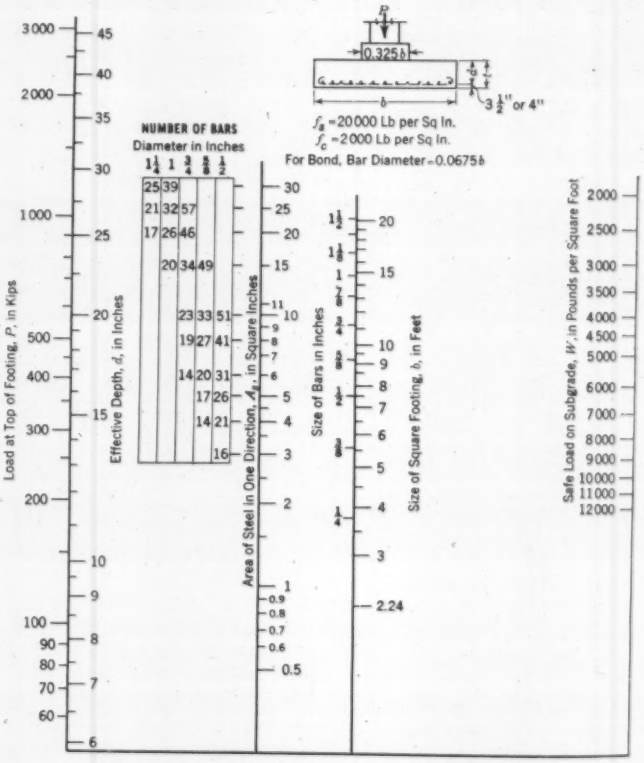
P
0.325b
b
3½" or 4"
f_s = 20 000 Lb per Sq In.
f_c = 2 000 Lb per Sq In.
For Bond, Bar Diameter = 0.0675b
NUMBER OF BARS
Diameter in Inches
1¼ 1 ¾ ⅝ ½
25 39
21 32 57
17 26 46
20 34 49
23 33 51
19 27 41
14 20 31
17 26
14 21
16
Load at Top of Footing, P, in Kips
Effective Depth, d, in Inches
Area of Steel in One Direction, A_s, in Square Inches
Size of Bars in Inches
Size of Square Footing, b, in Feet
Safe Load on Subgrade, W, in Pounds per Square Foot
2.24

FIG. 1. ALIGNMENT CHART FOR FOOTINGS

See Chart by Preston M. Geren, M. Am. Soc. C.E., on Page 649 of October 1932 Issue of CIVIL ENGINEERING

the dimensions of the square foundation for a column load of 300,000 lb, including the weight of the footing, and for a safe load on the subgrade of 3,000 lb per sq ft. Join 300 on the *P* axis and 3,000 on the *W* axis by a straight line. Where the line crosses the axes, read 10 ft for the size of the square footing, ¾ in. for the diameter of the rods, and 6 sq in. for the area of the steel. From the small table, opposite 6 sq in., it is found that fourteen ¾-in. rods in each direction in the footing are required. The effective depth of the footing is 15 in. and its thickness 15 + 4, or 19 in.

E. R. CARY, M. Am. Soc. C.E.
Professor of Railroad Engineering and Highways, Rensselaer Polytechnic Institute, Troy, N.Y.

Columbia, S.C.
January 12, 1933

SOCIETY AFFAIRS

Official and Semi-Official

Senate Favors Amendment of Emergency Relief and Construction Act

ACTIVITIES of the Society's Public Works Committee, in cooperation with other similar efforts, bid fair to result in beneficial changes in Government procedure as affecting emergency engineering construction. The establishment of active assistance under the Emergency Relief and Construction Act of 1932 has already been detailed in these columns. Also, the recommendations of the Society's committee, endorsed by the Board of Direction, to liberalize the provisions of this act, were featured in the February number.

Happily this latter movement is decidedly gaining ground. The principles are incorporated in the bill presented by Senator Robert F. Wagner amending the former act, and this bill on February 20, by the strong vote of 54 to 16, has passed the U.S. Senate. It now goes to the House of Representatives, where it is confidently hoped that approval will be given, and that thus the desired liberalizing amendments may become law during this session of Congress. If this is accomplished, it will permit construction on public works by the states, counties, municipalities, and other political subdivisions to go forward early in this year's construction season.

It is quite possible that the Local Sections may be called upon to indicate their support of these amendments of the Emergency Relief and Construction Act to their respective representatives in Congress. Such favorable action would have a beneficial effect on the sorely needed reconstruction activities.

High Lights of the Society Year

FROM ANNUAL REPORT OF THE BOARD OF DIRECTION FOR 1932

EIGHTY YEARS AGO, on November 5, 1852, a small group of civil engineers . . . organized the "American Society of Civil Engineers and Architects." The objects of the new Society were declared to be: "The professional improvement of its members, the encouragement of social intercourse among men of practical science, the advancement of engineering in its several branches, and of architecture, and the establishment of a central point of reference and union for its members." In the eighty years that have followed, those ideals have changed but slightly in phraseology and little in intent. The corporate situation, however, has changed markedly. Then, the Society was a small and hesitant group, largely of New York City residents. Now, it is a sturdy aggregation of more than 15,000 members situated throughout the world. This report, covering the eightieth year of the Society's experiences, records a present membership of 15,247; an expenditure of $347,-112; and proportionate intensification and diversification of activities.

Growth of membership, with consequent increase of income, was particularly marked in the years 1925 to 1931. In proportion, new facilities for service to members were practicable and new departments were developed, organized, and expanded. It may be said that the year 1930 was the peak year of the Society's history. The year now closed, the eightieth year, as a result of the long continued restricted business conditions and in common with practically every membership organization, has brought to these activities the necessity for readjustment and curtailment. Thanks to the loyalty of the membership and the fortunate financial condition of the Society, the readjustments have been necessary in only relatively minor degree. No units or fields of endeavor have been abolished, although practically all have been curtailed somewhat.

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The principal source of income consists of the dues from members. . . . Income from this source diminished $36,649 from last year's figures and $47,669 from those of 1930, respectively, losses of 15.1 and 18.7 per cent. . . . Publications were reduced in volume; the Spring Meeting was omitted; mileage allowance was reduced; salaries of the Staff were reduced; committees were asked to carry on so far as possible, after June 1, by correspondence and without the expense of meeting; contributions to the Local Sections, to American Engineering Council, and to Engineering Societies Library were decreased. . . . The year closed with a withdrawal from reserves of $8,572. Expenditures were 16.7 per cent less than those of 1931.

* * * * *

Membership at the close of the year was 57 greater than at the same date last year, thus maintaining the record that never has there been a year in which the Society's membership has not increased. . . . The Society throughout its 80 years has built up a selected group of members, loyal to the Society and its traditions, and ready to contribute of their time, their efforts, and their capabilities to the advancement of the profession. The value of the Society's members as men is far greater than the value of their dues as money. This the Board of Direction has recognized and 2,033 members who have supported the Society in years past, some 20 years, some 30 years and more, but who in these times are unable to pay dues, are continued, as "in good standing" today without such payment—continued as an asset in men, not money.

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Definite recognition should be made of the work done by the Local Sections of the Society in the extension of financial relief to those engineers in need thereof, whether or not members of the Society.

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Undoubtedly, the most outstanding instance of new activities undertaken during the past year is the "Normal Program for Public Works Construction to Stimulate Trade Recovery and Revive Employment," approved by the Board in principle and by the Executive Committee by resolution.

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This year, under the sponsorship of the Society's Committee on Registration, 23 representatives of collaborating societies came together and formulated what they have designated as the Model Law. This . . . has become the standard projected for attainment whenever new registration laws are contemplated or revisions in existing laws proposed.

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Heartily, with others, the Society this year has joined in setting up the Engineers Council for Professional Development. . . . The objects are the formulation of successive criteria of technical, cultural, and professional training by which can be measured the advance of the young man toward professional status, and the determination of suitable methods of recognition of his attainment of that status. In effect, its objective is to create a practicable minimum definition of the profession.

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The number of men placed during 1932 by the Employment Service has averaged about 48 per month.

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Publication of Memoirs in PROCEEDINGS was discontinued with

SIXTY-THIRD ANNUAL CONVENTION, June 27–30, 1933, During Engineers' Week, Century of Progress, Chicago

the September 1930 number. Since that time, approximately 270 memoirs have been published in pamphlet form.

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The attendance at the Reading Room during the year was 4,274.

Two hundred and sixty-seven periodicals are regularly received. Included in this number are many foreign periodicals, also a number of literary magazines and several daily newspapers.

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The number of members and others taking part in the preparation and discussion of papers, discussions, symposiums, and reports published in PROCEEDINGS was 212, and 123 discussions on papers published in 1931 PROCEEDINGS were also included in PROCEEDINGS for 1932.

The total attendance at the meetings of the Society was approximately 2,525. The registered attendance at the Annual Meeting was 1,776; at the Annual Convention, 249; and at the Fall Meeting, 493.

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There are at present 56 Local Sections. The Chattanooga Section, the Ithaca Section, and the Indiana Section approved by the Board of Direction on January 18, January 21, and July 4, 1932, respectively, have been added during the year.

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During the year there were 18 sessions of Technical Divisions held in connection with Society Meetings. . . . The policy of publishing abstracts in CIVIL ENGINEERING of papers, discussions, and reports presented at the Division sessions, has been continued during 1932.

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There are now 14,794 members enrolled in the Technical Divisions, as follows: City Planning, 1,553; Construction, 2,667; Engineering-Economics and Finance, 405; Highway, 2,182; Irrigation, 939; Power, 875; Sanitary Engineering, 1,655; Structural, 2,790; Surveying and Mapping, 870; Waterways, 858.

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There are at present 103 Student Chapters. The following were organized during 1932: Louisiana State University, North Dakota State College, Rhode Island State College, University of Delaware.

[*The complete annual report of the Board of Direction for 1932 will appear in the March 1933 issue of* PROCEEDINGS.]

Meeting of the Outgoing Board of Direction—Secretary's Abstract

ON JANUARY 16 and 17, 1933, the Board of Direction met at Society Headquarters with President Herbert S. Crocker in the chair; and present George T. Seabury, Secretary; Otis E. Hovey, Treasurer; and Messrs. Black, Buck, Chester, Coleman, Dusenbury, Enger, Gregory, Henny, Herrmann, Hoffmann, Holleran, Lupfer, MacCrea, Mead, Mendenhall, Morse, Riggs, Singstad, C. H. Stevens, J. C. Stevens, Stuart, Thomas, and Tuttle. (The members of the Incoming Board were present by invitation as observers for all or parts of the sessions.)

Annual Report of the Board of Direction

The Annual Report of the Board of Direction was presented and adopted. Extracts from this report are featured elsewhere in this issue.

Approval of Minutes of Board

The minutes of the meeting of the Board of Direction held on October 3 and 4, 1932, were approved.

Approval of Minutes of Executive Committee

The minutes of the meeting of the Executive Committee held on December 15, 1932, were approved and the actions outlined therein were adopted as the action of the Board.

"Share-the-Work" Campaign

A resolution was adopted with respect to a "share-the-work" campaign, as given in full on another page of this issue.

Revised Rail Sections Approved for American Standards

After consideration, the Board gave its approval to certain revised documents for American Standards for cross sections of rails used by electric railways. These were forwarded by the American Electric Railway Association with its favorable recommendation.

They are now to be submitted to the American Standards Association for approval as American Standards.

Topographic Mapping

Resolutions were adopted advocating extension of topographic mapping throughout the United States, which resolutions are shown in full on another page of this issue.

Suggested Code of Practice for the Construction Industry

Consideration was given to a suggested Code of Practice for the Construction Industry presented to the Policy Committee of the Construction League at its meeting in Washington last October. The views of the constituent members of the League were requested regarding this suggested code.

Following recommendations of the Executive Committee of the Construction Division, the Board approved in principle the preparation of an adequate Code of Practice for the Construction Industry by the Construction League of the United States; but urged that more consideration be given to the tentative rules now in draft form in order to better harmonize them with the present practice of the various constituent national organizations of the League.

University of Cincinnati Student Chapter

At the request of the Student Chapter of the University of Cincinnati, approval was given to the change in name from "Braune Civil Engineering Society (University of Cincinnati) Student Chapter" to "University of Cincinnati Student Chapter."

John R. Freeman

As given elsewhere in this issue, resolutions were adopted in memory of the late John R. Freeman, Past-President and Honorary Member of the Society.

Reports from Advisory Committees

The Board received reports from its six Board committees; from nine advisory, administrative, and professional committees; from two special committees; and from three of the research committees.

Committee on Professional Conduct

The Committee on Professional Conduct reported on six matters, action on one of which resulted in the acceptance of the resignation of the member.

Committee on Publications

The Committee on Publications presented a report reviewing its work for the year. In addition to its normal activities, the committee reported its satisfaction in the publication of special topics, including notes by the late Professor Suyehiro on engineering seismology and a number of admirable papers on various phases of the monumental George Washington Bridge. Without detriment to the quality of its work, the Committee has found it possible to effect increasing economies in an effort to maintain the amount and quality of its work in the face of decreasing facilities.

Committee on Districts and Zones

The boundaries of the Districts and Zones, as at present defined, were adopted as those which are to apply for the year 1933.

Survey of Student Chapters

The Committee on Student Chapters presented a detailed report with considerable statistical material regarding meetings and membership in the Chapters. During the year, 1,058 meetings were held by the 103 Chapters, with a total attendance of 36,358. Total membership was 4,393. As many papers or lectures were given by the students themselves as came from the faculty, outside speakers, and the Society in the form of lantern lectures.

The report referred to the Student Chapter Conference held in connection with the Fall Meeting at Atlantic City, N.J. Results of a survey of Faculty Sponsors and Contact Members were commented upon. Suggestions were offered that Group Conferences of Student Chapters be held in various sections of the country that the year's schedule of activities be prepared in advance to

arouse interest, that active participation by the students themselves in Chapter meetings be encouraged, and that the great effectiveness of inspection trips be noted.

Student Chapters Authorized

The formation of Student Chapters at New Mexico College of Agriculture and Mechanic Arts, Duke University, and Texas Technological College, was approved, making a present total of 105 Chapters.

Committee on Juniors

The Committee on Juniors recommended several administrative details, urging that committees on Juniors be appointed in each Local Section, and that reception and contact committees for Juniors should be active at sectional and national meetings. Attention was particularly called to the value of the Junior forums of the Los Angeles and San Francisco Sections; also to the "course in effective speaking" for Junior members of the New York Metropolitan Section.

Provision for Section Associates Not Approved

Consideration was given to the inquiry of the Panama Section as to a proposed provision in its constitution permitting the admission of non-members of the Society as "Section Associates." The Board, however, decided that non-members of the Society should not be admitted as "Section Associates."

Uniform Mechanics Lien Act

It was reported that the Committee on Legislation had given its approval to the provisions of the proposed Uniform Mechanics Lien Act, as formulated by a committee of the United States Department of Commerce. The following resolution was adopted:

RESOLVED that the final draft of the "Uniform Mechanics Lien Act" as recommended in the 1932 Report of the Society's Committee on Legislation be recommended as suitable for legislative action on the part of the various states, and in an endeavor to bring about uniformity in the treatment of such liens, that the Secretary be instructed to transmit copies of the act to the Local Sections of the Society with a request that such act be brought to the attention of the state legislature wherever existing statutes fail to provide equal powers and protection.

Public Works

In line with the suggestion of the Society's Committee on Public Works, the Board adopted resolutions outlining recommended modifications in Title II of the Emergency Relief and Construction Act of 1932, as given in the February issue, page 100.

Society's Relationship with American Engineering Council

Report of the special committee appointed to study the Society's relationship with American Engineering Council was received. The Board accepted its recommendation that the Society do not terminate its membership in American Engineering Council at this time.

Resolution of Highway and Building Congress, Detroit, Mich., January 1933

The Board gave its endorsement to the spirit of the following resolution, which was passed at the Highway and Building Congress held in Detroit on January 16, 1933:

RESOLVED, That recognizing the interdependence of all elements of the construction industry and desiring to work efficiently and harmoniously together in the spirit of this Congress program, we request the Construction League of the United States to create under a suitable title a Planning Board for the Construction Industry, which board would include two representatives of every body within the Construction League and every other national body present at this Detroit Highway and Building Congress, whether such body be a member of the league or not. To this joint agency thus authorized we pledge our full aid and cooperation so that out of the present economic emergency we may progress in the prompt and proper advancement of public and private construction in conformity with public needs.

Proposed Budget for 1933

The proposed budget for 1933, as recommended by the Executive Committee, was discussed in detail, amended somewhat, and recommended to the incoming Board for adoption. Other matters were considered and routine action was taken.

Meeting of the Incoming Board of Direction—Secretary's Abstract

THE BOARD OF DIRECTION met at the Headquarters of the Society on January 19, 1933, with President Alonzo J. Hammond in the chair; and present George T. Seabury, Secretary; Otis E. Hovey, Treasurer; and Messrs. Black, Buck, Crocker, Dufour, Enger, Gregory, Henny, Herrmann, Hoffmann, Holleran, Horner, Jonah, Lupfer, Mead, Mendenhall, Noyes, Perry, Riggs, Reed, Sanborn, Sherman, Stevens, Stuart, and Tuttle.

1933 Fall Meeting in Territory of Arizona Section

The outgoing Board had referred to the incoming Board the matter of holding and fixing the place for the 1933 Fall Meeting of the Society and after consideration of several invitations which had been received, it was decided to fix the place for holding the meeting in the territory of the Arizona Section, in response to invitation received from that Section.

Local Section Allotments

A new basis for Local Section allotments was adopted. In general, it provides that the allotments to Sections shall be exactly equal to, or some determined percentage of the local dues collected by the Section during the preceding calendar year, provided only that the total sum shall not exceed an amount equivalent to $3 per Local Section member. In the determination of the budget it was decided that no Section should receive less than it received in 1932.

Budget for 1933

The budget for 1933, as amended in several administrative details by both the outgoing and incoming Boards, was adopted.

Prequalification Questionnaire: Submitted by the Construction League of the United States.

Consideration was given to certain forms for Prequalification of Bidders as suggested by the Construction League and endorsement was given the principle of prequalification of bidders on private work, and, where it conforms to laws and ordinances, on public work.

Proposed Board of Water Resources Investigations

The Board adopted a statement in regard to the proposed Board of Water Resources Investigations, as given in full on another page of this issue.

Special Committees

The following personnel for committees for 1933 was approved, the President being given authority to complete it and to fill vacancies where necessary.

EXECUTIVE COMMITTEE: Alonzo J. Hammond, Chairman; Charles A. Mead, Vice-Chairman; Herbert S. Crocker, Francis Lee Stuart, and Arthur S. Tuttle.

COMMITTEE ON HONORARY MEMBERSHIP: Alonzo J. Hammond, Chairman; Herbert S. Crocker, F. O. Dufour, D. C. Henny, F. G. Jonah, Francis Lee Stuart, and Arthur S. Tuttle.

COMMITTEE ON DISTRICTS AND ZONES: F. O. Dufour, Chairman; F. C. Herrmann, Robert Hoffmann, and E. K. Morse.

COMMITTEE ON PROFESSIONAL CONDUCT: Henry Earle Riggs, Chairman; J. P. H. Perry, Ralph J. Reed, James F. Sanborn, and J. C. Stevens.

COMMITTEE ON PUBLICATIONS: Henry R. Buck, Chairman; John H. Gregory, L. G. Holleran, E. P. Lupfer, and H. J. Sherman.

COMMITTEE ON MEMBERSHIP QUALIFICATIONS: M. L. Enger, Chairman; E. B. Black, W. W. Horner, H. D. Mendenhall, and E. N. Noyes.

COMMITTEE ON RESEARCH: V. R. Covell, Chairman, term ending January 1934; Thaddeus Merriman, term ending January 1935; George E. Beggs, term ending January 1936; Thorndike Saville, term ending January 1937; and John H. Gregory, Contact Member.

COMMITTEE ON LOCAL SECTIONS: Robert Follansbee, Chairman, term ending January 1934; N. T. Veatch, Jr., term ending January 1935; A. T. Dusenbury, term ending 1936; V. H. Cochrane, term ending January 1937; and E. B. Black, Contact Member.

COMMITTEE ON JUNIORS: A. M. Lund, Chairman, term ending January 1934; H. P. Treadway, term ending January 1935; J. T. L. McNew, term ending January 1936; Charles M. Davis, term ending January 1937; and E. N. Noyes, Contact Member.

COMMITTEE ON STUDENT CHAPTERS: J. J. Doland, Chairman, term ending January 1934; T. A. Leisen, term ending January 1935; C. C. Williams, term ending January 1936; R. L. McCormick, term ending January 1937; and E. P. Lupfer, Contact Member.

COMMITTEE ON ENGINEERING EDUCATION: A. H. Fuller, Chairman, term ending January 1934; H. F. Ferguson, term ending January 1935; C. L. Eckel, term ending January 1936; R. H. Ford, term ending January 1937; and Henry Earle Riggs, Contact Member.

COMMITTEE ON PUBLIC EDUCATION: Walter D. Binger, Chairman, term ending January 1934; Abel Wolman, term ending January 1935; D. H. Sawyer, term ending January 1936; L. J. Johnson, term ending January 1937; and J. P. H. Perry, Contact Member.

COMMITTEE ON LEGISLATION: Albert Givan, Chairman, term ending January 1934; R. W. Lawton, term ending January 1935; E. J. Schneider, term ending January 1936; W. W. Crosby, term ending January 1937; and F. C. Herrmann, Contact Member.

COMMITTEE ON REGISTRATION OF ENGINEERS: L. L. Hidinger, Chairman, term ending January 1934; R. E. Warden, term ending January 1935; W. T. Chevalier, term ending January 1936; Charles H. Paul, term ending January 1937; and W. W. Horner, Contact Member.

COMMITTEE ON SALARIES: E. P. Goodrich, Chairman; A. B. McDaniel, E. O. Griffenhagen, W. F. Reeves, Arthur Richards, and L. G. Holleran, Contact Member.

COMMITTEE ON REGIONAL MEETINGS:

Annual Meeting: Arthur S. Tuttle, Chairman; H. R. Buck, L. G. Holleran, Charles A. Mead, and J. P. H. Perry.

Spring Meeting: F. O. Dufour, Chairman; W. W. Horner, H. D. Mendenhall, E. K. Morse, E. N. Noyes, and H. J. Sherman.

Summer Meeting: F. G. Jonah, Chairman; M. L. Enger, Robert Hoffmann, E. P. Lupfer, and H. E. Riggs.

Fall Meeting: D. C. Henny, Chairman; E. B. Black, F. C. Herrmann, Ralph J. Reed, and J. C. Stevens.

COMMITTEE ON TECHNICAL PROCEDURE: Alonzo J. Hammond, Chairman; William Bowie, H. R. Buck, V. R. Covell, R. W. Crum, F. O. Dufour, A. P. Greensfelder, George H. Herrold, Charles Keller, F. R. McMillan, J. C. Stevens, J. L. Burkholder, Edward Bartow, Lynne J. Bevan, Charles M. Spofford, and George T. Seabury, Secretary.

COMMITTEE ON PROFESSIONAL ACTIVITIES: Alonzo J. Hammond, Chairman; E. B. Black, F. C. Herrmann, L. G. Holleran, W. W. Horner, E. P. Lupfer, E. N. Noyes, J. P. H. Perry, Henry Earle Riggs, James F. Sanborn, and George T. Seabury, Secretary.

COMMITTEE ON ACCREDITED SCHOOLS: Charles M. Spofford, Chairman, term ending January 1934; H. A. Thomas, term ending January 1935; Milo S. Ketchum, term ending January 1936; J. G. Bennett, term ending January 1937; and M. L. Enger, Contact Member.

Investigations of Water Resources Proposed

APPROVAL WAS GIVEN by the Board of Direction at its recent meeting to a project to unify and correlate activities in the Federal Government, dealing with water resources. The scope of the proposed action is concisely stated in the motion adopted by the Board in the following terms:

The American Society of Civil Engineers joins with American Engineering Council in recommending, for the purpose of elimination of duplication of work and as a means of promoting economy:

I. The immediate establishment of an interdepartmental Board of Water Resources Investigation for the purpose of correlating the investigational functions of the various Federal agencies dealing with water resources.

II. The inauguration of studies for the purpose of investigating the feasibility of establishing similar boards to correlate the supervisory and regulatory functions of the Federal Government relating to water resources.

III. The delegation of all construction relating to water resources to a Bureau of Construction within a Department or Division of Public Works if and when established.

IV. Studies looking to the advisability of the ultimate establishment of a Bureau of Water Resources within the proposed Department or Division of Public Works, wherein would be coordinated, as far as feasible, the activities relating to water resources.

Prospective Code of Practice for the Construction Industry

STEPS HAVE BEEN taken for the formulation and issuance of a Code of Practice for the Construction Industry. Responsibility for these steps has been vested in the Code of Practice Committee of the Construction League of the United States. This committee has already set up a tentative or suggested code, although it is not yet in final and approved form.

In agreement with recommendations of the Executive Committee of the Construction Division of the Society, the Board of Direction went on record at its January meeting as approving in principle the preparation of such a code. If the proposed undertaking is followed, further study will be given to the tentative rules, in order to better harmonize them with the present practice of the various constituent national organizations of the Construction League.

Endorsement of "Share-the-Work" Plan

IN RECOGNITION of the worth-while efforts that are being made to spread employment, the Board of Direction at its January Meeting took appropriate action. Its attitude, based on suggested resolutions of the Executive Committee, is indicated in the following, which is self explanatory:

WHEREAS, The unemployment situation in this country is one of the most serious problems that confronts the nation and is causing distress to millions of people, and

WHEREAS, The President of the United States has recommended that the available work be distributed as far as possible as a means of relieving this situation and a "share-the-work" campaign is now under way under the direction of the 12 Federal Reserve District Committees for the purpose of securing the cooperation of employers and their employees in making a wider distribution of employment; now therefore be it

Resolved, That the Executive Committee of the American Society of Civil Engineers hereby endorses this "share-the-work" campaign.

Boundaries of Society Districts and Zones Unchanged

IN ORDER THAT the Corporate Members of the Society may be prepared to indicate their choice of nominees for forthcoming vacancies among the Society officers, it is customary to announce, soon after the beginning of the year, any change in the boundaries of the Districts and Zones that will be represented by these Directors and Vice-Presidents. The Constitution provides that such announcement be made "not later than April 1 in each year."

The Committee on Districts and Zones, after due consideration, has recommended that no change be made in the boundaries for the current year. This report was adopted by the Board of Direction at its meeting on January 16, 1933. Full announcement of the existing division into both Districts and Zones will ac-

company the First Ballot, when it is mailed to the Corporate Members in June. In the meantime, it is of interest to know that the geographical allocation of the membership is to remain the same as in the past two years, since the creation of the new District, No. 16.

Question of Engineering Ethics

STATEMENT OF CASE AND ARGUMENTS GOVERNING DECISION BY THE BOARD OF DIRECTION

THE VILLAGE OF ———— was desirous of improving its water supply. Of the engineers who came to the attention of its officials, one firm of consultants (it might have been an individual consultant) was retained under an agreement to study the several available sources of water and to render a report with recommendations. Let this consultant be designated "Engineer A."

Engineer A made a report with surveys and recommendations as to source, plan of development, cost, etc., and received his pay for the report. The public was informed of the plan proposed by Engineer A, and at a public meeting voted in favor of the plan.

At this point Engineer B sought to be engaged. He approached the village officials offering his services. He knew that Engineer A had made the report and he knew of the vote at the public meeting. Obviously Engineer B might offer to carry out the approved plan, a thing which manifestly could be better done by the one who drafted that plan, or he might suggest a new scheme which he would advocate as preferable. In this instance Engineer B advocated an alternative scheme.

Presupposing that both Engineer A and Engineer B were eminently qualified to carry out either scheme, was Engineer B ethical in seeking engagement from the village officials? This question has recently had the attention of the Board of Direction. A brief analysis of the case follows:

Engineer B maintained:

That it was for the public good that the scheme he thought better be the one to be adopted;

That the report having been accepted and paid for, no relationship of continuance existed between the village and Engineer A;

That there being no relationship of continuance existing between the village and Engineer A, all engineers were at liberty to offer alternative schemes or alternative qualifications as future consultant;

That no effort "to attempt to injure falsely or maliciously, directly or indirectly, the professional reputation, prospects, or business of another engineer" was involved;

That no effort "to supplant another engineer after definite steps have been taken toward his employment" was involved;

That no effort "to review the work of another engineer for the same client, except with the knowledge or consent of such engineer or unless the connection of such engineer with the work has been terminated," was involved.

Expressions of opinion by the members of the Board of Direction were:

That if the public good was predominant in the mind of Engineer B, that end could well have been sought through consultation with Engineer A rather than by confusing the public and the village officials through the proposal of an alternative scheme after vote had been taken on a specific plan;

That by proposing an alternative scheme, with employment in mind, comparisons disparaging of the approved plan were necessary, and disparagement of the engineer who devised that plan could hardly have failed to become incident if not actually vigorous;

That if it were to be generally recognized by consultants that the moment any report had been made and paid for all specialists in that field are ethically at liberty to present alternative schemes and to urge themselves as equally or better qualified for engagement, there would result great confusion in the lay and official mind and accompanying disrespect for the ability and the ethics of engineers;

That a comparison with the practices in the medical profession will permit a clear view of the proprieties. A sick person, when in doubt about the treatment he is receiving, may discharge his regular physician and call in another, but physicians do not rush into a sick room, urging their engagement to render alternative mode of treatment;

That the "prospects" of Engineer A were injured although not necessarily falsely or maliciously; that in the suggestion of an alternative scheme the professional reputation of Engineer A was *prima facie* in process of injury although not necessarily falsely nor maliciously; that in the presentation of superior merit, either in scheme or in capabilities, the professional reputation of Engineer A was likely to be injured either falsely or maliciously;

That Engineer A, his plan having been accepted to the point of receiving a favorable vote, had a right to consider that definite steps had been taken toward his employment to carry that plan through to a conclusion;

That although the engagement for the preparation of the report had been terminated, the vote to adopt the plan presented in that report indicated that the connection of Engineer A with the carrying out of that plan was not considered by the client as terminated and that therefore Engineer A's work should not have been reviewed without his knowledge or consent.

The Board deemed the act of Engineer B to be unethical.

OBTAINING UNEMPLOYMENT RELIEF

Judging from the correspondence received at Headquarters, apparently many unemployed engineers throughout the United States are unaware that various forms of relief are available in their own communities. Practically every state, county, and city has raised or appropriated funds to provide for the relief of the unemployed. These funds are being expended in various ways.

Experience during the past months indicates that all engineers out of work and in need of assistance should first acquaint themselves with the local method of providing relief. This may be done by getting in touch with any of the following persons in their community: (1) officers of local sections of national engineering societies, (2) officers of local engineering clubs, (3) the City Engineer, or (4) the County Engineer.

If the member is so located as to be unable to reach any of the persons mentioned, a letter to the Secretary of the Society will bring suggestions as to what seems to be the next best procedure.

Need of Topographic Mapping

EXPERIENCES over the past few years have demonstrated the need of topographic mapping and the possibility of cooperation between state and Government agencies. After reviewing the situation and the possibilities offered, the Society's Board of Direction on January 16, 1933, adopted the following resolution:

WHEREAS, The modern topographic maps prepared by the United States Geological Survey in cooperation with the State Geological Surveys or other similar state engineering divisions have proved invaluable in the location and design of primary and secondary highways, wherever such maps have been available, and furnish a great amount of accurate information which is essential to a proper study of many highway engineering problems, which information can be developed only at the expense of considerable time and funds if the maps are not available; and

WHEREAS, The topographic mapping of many problematical areas of the country is still incomplete and is urgently needed; and

WHEREAS, The United States Coast and Geodetic Survey and the United States Geological Survey have funds available to pay one-half the cost of such work; therefore be it

Resolved, That the Federal and state officials in charge of topographic surveys be encouraged and urged to proceed with this valuable work; and be it further

Resolved, That the Congress of the United States and the legislatures of the several states be informed of the great financial and engineering value of these topographic surveys in the highway construction programs, and that the said Congress and legislatures be urged to make appropriations for the execution of these surveys to that degree which is fully commensurate with the financial ability of the Federal Government and the various state governments; and be it further

Resolved, That in those states where mapping agencies do not

exist or they do not have adequate funds, that the State Highway Commissions give consideration to the plan of their cooperating with the Federal mapping agencies on a fifty-fifty basis and be it further

Resolved, That copies of these resolutions be sent to those in charge of the topographic survey work for the Federal Government and for the various states for transmission by them to their respective budgetary, congressional, and legislative officials.

It should be noted that other organizations, notably the American Association of State Highway Officials and the American Engineering Council, have gone on record with similar views. This action will be of particular interest to members and Local Sections in communities where the availability of this method is made an issue.

The Engineering Foundation Elects Officers

AT THE ANNUAL meeting of The Engineering Foundation, held on February 16, 1933, the following officers were elected for the ensuing year:

GEORGE W. FULLER, M. Am. Soc. C.E., representing the Society, Chairman
HARRY P. CHARLESWORTH, representing the American Institute of Electrical Engineers, First Vice-Chairman
H. C. BELLINGER, representing the American Institute of Mining and Metallurgical Engineers, Second Vice-Chairman

The members of the Executive Committee were also chosen, as follows:

D. ROBERT YARNALL, representing the American Society of Mechanical Engineers
JOHN V. N. DORR, member at large
ALFRED D. FLINN, M. Am. Soc. C.E., Director and Secretary of The Engineering Foundation.

Society Publications Are Popular

AS REGARDS the number of papers submitted for publication, January was a record-breaking month for CIVIL ENGINEERING. Some of these papers were received from members who happened to be in attendance at the Annual Meeting, but most of them came in through the usual channels. The result was in the nature of a deluge of articles for possible publication. Papers in the foregoing category are not to be confused with the so-called "Annual Meeting Papers," all of which are being printed in abstract form in this issue.

During the month of January alone, papers to the number of 17 were added to the files for study by the Committee on Publications and action with respect to their suitability for CIVIL ENGINEERING. It goes without saying that not all of these can be used, yet among them there are many of more than usual merit. The prospects for attractive issues during the coming months are very bright.

In addition to those papers in the category just mentioned, there is the usual quantity in the hands of the Committee under consideration for PROCEEDINGS. Here also a fairly high rate of mortality seems inevitable. Faced with the necessity of limiting itself to a somewhat smaller quantity of published material during 1933, the Committee has a real task in so making and diversifying its choices as to yield the maximum of permanent benefit to the membership and to the profession.

Resolutions on the Death of John R. Freeman

MINDFUL of the great services to humanity and the engineering profession of the late John R. Freeman, Past-President and Honorary Member of the Society, the Board of Direction at its recent meeting unanimously adopted the following resolutions:

WHEREAS, It has pleased Almighty God to remove from our midst our late Honorary Member and Past-President, John Ripley Freeman, and

WHEREAS, We realize that in his death, the world has lost a most useful citizen, the engineering profession an able leader, and the American Society of Civil Engineers a valued and loyal member, now therefore be it

Resolved, That the Board of Direction of the American Society of Civil Engineers hereby records its profound sorrow at the passing of its respected and revered friend and supporter. Be it further

Resolved, That the sincere sympathy of the Board of Direction be conveyed to his bereaved family; and be it further

Resolved, That a page be set aside in the minutes of the Board upon which shall be inserted this resolution, a copy of which shall also be transmitted to his family.

In a somewhat similar vein a group of representatives of Student Chapters, assembled at the Fall Meeting of the Society in Atlantic City on October 7, 1932, forwarded the following expression of their sentiments for Dr. Freeman to the Board of Direction:

The Student Chapter representatives gathered at the Student Chapter Conference at Atlantic City on October 7, 1932, learned with deep regret of the death yesterday of Mr. John R. Freeman.

Mr. Freeman was an Honorary Member of the American Society of Civil Engineers, but was known to most of us more particularly because of his interest in the shaping of the careers of the younger men.

The Freeman Traveling Scholarships, made possible by his generous donations, provided exceptional opportunities for young engineers to further their education.

By vote of this conference, this expression of our sincere appreciation of Mr. Freeman, and our sense of loss at his death is transmitted with the request that it be incorporated in the minutes.

By vote of the Board, the foregoing action was ordered included in the record.

Coming Society Meetings

PLANS HAVE now been approved by the Board of Direction for holding both the Annual Convention and the Fall Meeting of the Society. For many months active preparations have been going forward, looking toward a banner Convention to be held at Chicago on June 27–30 in connection with the Century of Progress Exposition. This Convention will be held in conjunction with a large number of other meetings at approximately the same time, combining into an "Engineers' Week," which bids fair to become memorable. Further announcements and details will be forthcoming as plans now under way mature.

For the Fall Meeting, the Southwest will again have an opportunity of entertaining the Society. For this meeting, the Board has fixed its mind on Arizona, especially favoring the district around Phoenix. While the exact date has not been determined, it is expected that the Fall Meeting as usual will occur some time early in October.

Columbia University Scholarship Open

ADVANCE NOTICE is being given of the availability of the Columbia University Scholarship for the coming academic year. This scholarship has been established in the honor of Horatio Allen, an illustrious member of the Class of 1823 at Columbia, who numbered among his distinctions a term as third President of the Society.

Provisions for awarding this prize have been made flexible enough to serve a variety of qualifications. The minimum requisite preparation is the successful completion of at least two years of work at an accredited school, covering general preparatory courses, including engineering mathematics and drafting. With such minimum preparation, a candidate will require two years to complete his work for the B.S. degree and an additional year to attain the C.E. degree. It is therefore possible that the Columbia scholarship may be made available for three consecutive years, if the progress of the student is sufficiently successful in the opinion of the Society's committee and the University authorities.

More complete preparation is also given credit, with correspondingly shorter courses at Columbia University. This applies even to candidates who have completed the undergraduate course.

Applicants are advised to write to the Society for full details. The scholarship, which has a total money value of about $700 per year, will become effective as of September 1933. Applications must be in hand by June 1.

A Preview of Proceedings

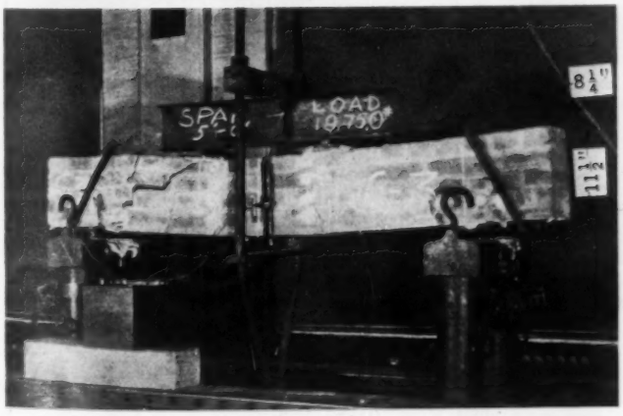
A typical state capital is Boston, Mass., a city in which the state administrative function has had a minor effect on the city plan. A paper on the problems met in planning this city will appear in the March issue of PROCEEDINGS. *The other main paper in this issue will set forth methods and results of using brick masonry for such construction as beams, slabs, retaining walls, and circular tanks. Although brick masonry has not been considered suitable, and therefore has not been extensively employed, for such purposes in the past, it is now found to have a definite field of usefulness for such construction. The Annual Report of the Secretary of the Society and an unusually large number of discussions will complete the forthcoming issue of* PROCEEDINGS.

THE PLAN OF BOSTON, MASS.: A CAPITAL CITY

IN THE BEAUTIFYING and laying out of capitals, city planners have one of their greatest opportunities for demonstrating the sheer necessity for their talent in modern civilization. The paper by Arthur C. Comey, M. Am. Soc. C.E., illustrates this point forcibly. Mr. Comey classifies the capital cities of the United States broadly in three classes, as those in which the state administrative function is the only activity of the city to be considered in planning; those in which this function is the most important of several activities; and those in which it is a relatively minor consideration.

Examples of a city in each of these three classes are, respectively, Olympia, Wash.; Denver, Colo.; and Boston, Mass. Boston is a world metropolis, a commercial center, and a seaport. It is occupied with industrial, educational, and other activities in addition to the administrative functions of a state capital. Mr. Comey traces the origin and early development of the city as a basis for explaining the many modern problems of city planning. Because of the complex nature of the city's many activities, the plan of Boston must involve a comprehensive consideration of railroad, water supply, and sanitation problems as well as the general administration problems of the city planning program.

The contribution of Mr. Comey is of particular interest in that he acknowledges the transient stage of the present planning project in Boston. Certainly there is opportunity in this case for those who are interested in city planning to contribute from their own experience and studies in an effort to group together in one place all the possible solutions of this tremendously important problem.



REINFORCED BRICK MASONRY CONSTRUCTION
Below, 10-Ton Load on a 5-Ft Brick Beam Reinforced with 2½-In. Deformed Bars with Hooked Ends
Above, House Construction

DEVELOPMENT IN REINFORCED BRICK MASONRY

FOR THE FIRST TIME in the history of PROCEEDINGS, members of the Society and others interested will have an opportunity to discuss the relative merits of reinforced brick masonry. The paper on "Development in Reinforced Brick Masonry," by James H. Hansen, Jun. Am. Soc. C.E., contains a brief history of the development of brick masonry from the time of its first introduction by Marc Isambard Brunel in the construction of the Thames Tunnel. Mr. Hansen presents a summary of the findings of various investigators in this field since that time. The text data are arranged in tabular form under comparable units that can be easily analyzed. Fourteen typical sections of reinforced brick beams and slabs are illustrated. The paper opens up for discussion such important correlative factors as modulus of elasticity, deflection, strength of beams, and the effectiveness in strength in shear of various mixes of sand-cement and sand-lime-cement.

Among the conclusions presented by the author in this paper are the following: (1) Assumptions acceptable in the design of reinforced concrete structures are equally acceptable in the design of reinforced brick masonry. (2) A working stress of 0.4 f_c' can be safely allowed on reinforced brick masonry. (3) The use of a deformed round rod is recommended in that it will result in a higher bond stress. (4) Bond stresses should be limited to 80 lb per sq in. (5) Shear stresses should be limited to 25 or 30 lb per sq in., and this limitation would necessitate the use of stirrups or bent-up bars in most beams. (6) To develop maximum strength, the reinforcing rods should be placed in vertical joints. (7) The face of the brick that develops the greatest compressive strength should be placed normal to the line of compressive stress in the beam. (8) The value of the ratio of the moduli of elasticity of steel and brick beams is about 20 to 30. (9) The best mortar for use in reinforced brick beams is a cement, lime, and sand combination in the proportion of 1 : 0.25 : 3.

Commenting on the general advantages of reinforced brick work, the author points out that it eliminates all vertical forms; it is especially adaptable for conditions in which there is small working space; and its finished appearance can be made especially attractive. This type of construction, it is claimed, is particularly adaptable for such construction as retaining walls, circular tanks, floor slabs, stadiums, foundation walls, and tunnels.

News of Local Sections

CLEVELAND SECTION

A dinner-meeting of the Cleveland Section was held at the Chamber of Commerce Club on January 24, with eight former presidents of the Section in attendance as guests of honor. There were present, also, 26 members of the Section and 21 members of the Case School of Applied Science Student Chapter. After a business session, W. A. Stinchcomb, Director of the Cleveland Metropolitan Park Board, gave an interesting talk on the subject of "The Future Possibilities of Park Systems."

ILLINOIS SECTION

A meeting to honor A. J. Hammond and Herbert S. Crocker, President and Past-President of the Society, respectively, and Charles L. Strobel, newly elected Honorary Member, was held by the Illinois Section at the Chicago Engineers Club on December 12. Included in the routine business session was the election of officers for 1933, an item concerning which was published in the February issue of CIVIL ENGINEERING.

METROPOLITAN SECTION

The use of high-voltage direct current for the distribution of electric energy in the future was predicted by Charles W. Stone, consulting engineer for the General Electric Company, of Schenectady, N.Y., in his address at the regular meeting of the Metropolitan Section, held in the Engineering Societies Building, New York, N.Y., on February 15. He believes that this will be made possible by the development of gas-filled tubes that will transform alternating currents of high voltage into direct current, or the reverse.

The next speaker was Dr. Alfred N. Goldsmith, Former President of the Institute of Radio Engineers, and consulting engineer of New York, who said that the present state of knowledge of radio transmission does not indicate that the possibility of radio transmission of electrical energy for commercial use has been even remotely approximated. George A. Orrock, consulting engineer of New York, then discussed the effect of the decreasing cost of steam-generated energy upon the future distribution system. The program was concluded by A. H. Kehoe, Vice-President of the New York Edison Company, who discussed the future needs of the Metropolitan Area.

NEW MEXICO SECTION

On December 20, the annual meeting of the New Mexico Section was held in Albuquerque. Included in the business transacted was the election of officers for 1933, which resulted as follows: George M. Neel, President; and H. C. Neuffer, First Vice-President. These were the only offices to be filled this year. Most of the meeting period was devoted to a lengthy discussion of the desirability of getting through the legislature a new law governing the registration of surveyors and professional engineers.

PHILADELPHIA SECTION

A dinner-meeting was held by the Philadelphia Section on January 23, with 90 in attendance at the dinner and 200 at the meeting. The first speaker was Oscar B. Coblentz, Vice-President of the Merrit-Chapman and Scott Corporation, of Baltimore, Md., who described the construction of the Ocean City-Somers Point Bridge, recently built for the New Jersey State Highway Department. An interesting address on "Maintenance by Welding" was then given by Allen R. Wilson, Engineer of Bridges and Buildings for the Pennsylvania Railroad Company; and the program was concluded by an address on the "Installation of a Modern-Type Steel Deck for Bridges and Buildings," presented by Joseph G. Shryock, Chief Engineer of the Belmont Iron Works.

PORTLAND (ORE.) SECTION

There were 72 in attendance at the meeting of the Portland Section, held in the Chamber of Commerce Building on January 11. Included in the business session was the election of officers for 1933, which resulted as follows: Harold A. Rands, President; Lyman Griswold, Second Vice-President; and G. H. Canfield, Secretary. Officers whose terms hold over from 1932 are: C. F. Thomas, First Vice-President; and Geary Kimbrell, Treasurer. The speaker of the evening was Ben Torpen, who gave an interesting and informative address on hydraulic construction in Russia, where he was recently engaged in hydraulic planning and construction work.

ROCHESTER SECTION

The tenth annual meeting of the Rochester Section was held at the University Club on January 5, with 18 in attendance at the dinner and 21 at the business meeting. Numerous committee reports were read, and officers for 1933 were elected as follows: Henry Lawrence Howe, President; Carl C. Cooman, First Vice-President; and Cornelius E. Elmendorf, Second Vice-President. Charles F. Starr remains in office as Secretary-Treasurer, as he was elected last year for a two-year term.

The feature of the occasion was an illustrated address given by Frank P. McKibben, Consulting Engineer of Black Gap, Pa.

SAN DIEGO SECTION

The San Diego Section announces that officers for 1933 have been elected as follows: R. R. Rowe, President; H. A. Noble, Vice-President; and L. L. Mills, Secretary-Treasurer.

At the regular monthly dinner-meeting of the San Diego Section, held on January 26, George W. Hawley, Deputy State Engineer, spoke on "State Supervision of Dams," describing the act that empowers the State Engineer to supervise the design, construction, maintenance, and operation of the 770 dams in California. There were 21 present.

SACRAMENTO SECTION

Frequent meetings of the Sacramento Section have been held during the past two months. Among the speakers whom the members have been privileged to hear upon such occasions are the following: Morrough P. O'Brien, Assistant Professor of Mechanical Engineering at the University of California; Baldwin M. Woods, dean of the College of Engineering of the University of California; C. C. Morris, of the U.S. Bureau of Public Roads; and E. H. Fletcher, of the U.S. Weather Bureau.

On January 10, the following officers for 1933 were elected: William F. Turner, President; C. H. Kromer, First Vice-President; D. R. Cate, Second Vice-President; and Norwood Silsbee, Secretary.

SAN FRANCISCO SECTION

The San Francisco Section announces that the following officers for 1933 have been elected: H. H. Hall, President; N. A. Bowers and Charles G. Hyde, Vice-Presidents; and Harold B. Hammill, Secretary-Treasurer.

SEATTLE SECTION

The officers elected by the Seattle Section for 1933 are as follows: M. O. Sylliaasen, President; Thomas D. Hunt, Vice-President; and Miles E. Clark, Secretary-Treasurer.

ST. LOUIS SECTION

On January 23, a meeting of the St. Louis Section was held at the Mayfair Hotel. About 50 members and guests enjoyed an address and motion pictures presented by Harland Bartholomew, describing his recent extended stay in Bogota, Colombia. Interesting accounts of the Annual Meeting of the Society were given by Col. F. G. Jonah and W. W. Horner.

TOLEDO SECTION

The Toledo Section has elected the following officers for 1933: Robert H. Randall, President; George Champe, First Vice-President; Albert H. Smith, Second Vice-President; and Porter W. McDonnell, Secretary-Treasurer.

Student Chapter News

BROOKLYN POLYTECHNIC INSTITUTE

On December 19, the Brooklyn Polytechnic Institute Student Chapter made an interesting inspection trip to the Great Falls of the Passaic River, at Paterson, N.J., the site of one of the oldest power and industrial developments in the country. Power is generated and transmitted electrically from turbine water wheels to numerous mills in the vicinity, and the surplus energy is sold under contract to the Public Service Corporation of New Jersey.

COOPER UNION

An audience of approximately 100 attended the first regular meeting of the Cooper Union Student Chapter, held on December 19. The feature of the occasion was an address by R. L. Williamson, of the Aluminum Company of America, who spoke on the subject of "Aluminum and Its Structural Uses." The students were particularly interested in the subject because, although it is one which is not included in the school curriculum, it relates closely to both classroom and laboratory investigations.

KANSAS STATE COLLEGE

On January 5, the Kansas State Student Chapter enjoyed a meeting, at which R. W. Crum, Director of the Highway Research Board, Washington, D. C., was the principal speaker. He chose for his subject "Engineering Specifications and Inspection." At the present time tentative arrangements are being made for the senior inspection trip to Chicago and vicinity.

American Engineering Council

National representative of 26 engineering societies, with a constituent membership of 60,000 professional engineers, reports civil engineering news of the Federal Government

Liberalization of Relief Act

WHILE the Reconstruction Finance Corporation, under the provisions of Title II of the Emergency Relief and Construction Act of 1932, authorized 13 loans totaling $3,589,000 during the month of January, vigorous efforts were under way to liberalize the provisions of this act so as to make credit for construction purposes more readily available. The outstanding move in this direction was Senate bill 5336, introduced by Mr. Wagner on January 6. That part of this bill relating to Title II of the present act, contemplates its liberalization by eliminating the self-liquidating clause in connection with loans to states, municipalities, and other governmental agencies. The bill also stipulates the rate of interest to be charged on loans, limiting such rate of interest to one-half of one per cent more than the rate established for the last issue of bonds of the United States preceding the making of each loan.

At hearings held February 2 for the purpose of discussing this bill, the testimony of prominent engineers was received by a subcommittee of the Senate Committee on Banking and Currency. While these engineers spoke as individuals representing various organizations, they appeared as a unified body, having previously held a conference under the auspices of the American Engineering Council.

As first witness, A. J. Hammond, President of the Society, presented six principles [See Board of Direction Resolution of January 16, 1933, on page 100 of the February issue] advocating liberalization of the act and presented for the record the endorsement of those principles by the following bodies:

American Engineering Council
American Institute of Architects
American Road Builders Association
American Society of Municipal Engineers
American Water Works Association
Conference of State Sanitary Engineers
Construction League of the United States (9 constituent members)
National Committee for Trade Recovery
State and Provincial Health Authorities of North America
American Society of Civil Engineers

Specific recommendations and testimony as to various phases of the operations of the Relief Act were included in the testimony of the following engineers, who succeeded Mr. Hammond in the witness chair:

E. J. Russell, President, American Institute of Architects
H. P. Eddy, M. Am. Soc. C.E., representing the Public Works Committee of the Society; and the Committee on Water Works Betterments of the American Water Works Association
Martin Dodge, of the Banking and Industrial Committee, 2d Federal Reserve District, New York City
Col. George W. Walbridge, Chairman of the Legislative Committee, Associated General Contractors of America
Otto T. Mallery, Economist
Robert Kohn, Chairman of the Construction League of the United States
W. L. Stevenson, M. Am. Soc. C.E., Chairman of the Conference of State Sanitary Engineers
John P. Hogan, M. Am. Soc. C.E., representing the National Committee for Trade Recovery; and the Public Works Committee of the Society
R. C. Marshall, Jr., M. Am. Soc. C.E., Vice-President, American Engineering Council
C. E. Grubb, M. Am. Soc. C.E., representing the American Road Builders Association

While the witnesses were unanimous in support of the provisions contained in the Wagner bill, there was also a unanimity of opinion to the effect that the provisions of the bill should be broadened so as to include all of the six recommendations endorsed by the several organizations represented.

The subcommittee held an executive session on Monday, February 6, and reported the bill to the full committee with changes which generally met the provisions advocated by the engineering profession and construction industry. Senator Wagner and other members of the Senate are making every effort to secure consideration of this measure at the short session of Congress, and it is considered possible that it will receive favorable action within the few remaining legislative days.

Legislative Situation

In spite of the fact that the attention of both houses has been almost exclusively occupied with the consideration of appropriation bills for the fiscal year 1934, the only measure which has reached the point of becoming law is the first 1933 deficiency bill. While the appropriation bills for the Treasury and Post Office, the Department of the Interior and the Department of Agriculture have been reported in the Senate, none of these measures has received final action.

Of these three bills, that for the Department of the Interior is of special interest to engineers because it includes the appropriations for the U. S. Geological Survey. As passed by the House, the appropriations for the Survey were considerably reduced from those of the budget estimates because of the general feeling that State funds for cooperative purposes would not be as readily available as in the past. These reductions have been in part offset by the Senate Committee, which considered the bill and which recommended increases in the items for geologic surveys, Alaskan mineral resources, and the printing and binding of the reports of the bureau.

Government Reorganization

With the approval by the House of Representatives of the Cochran Resolution invalidating President Hoover's Executive Orders for Government Reorganization, this problem has been definitely relegated to the incoming administration. There is ample evidence that the President-Elect will make an earnest effort to secure some action in this direction. An effort is now being made in Congress to secure wider executive powers which will permit the President to put reorganization recommendations into effect without permitting adverse action on the part of only one House of Congress to nullify such recommendations, as was the case with the recent Executive Orders. The Special Economy Committee of the Senate has drafted a rider providing for such authority, which it hopes to attach to the Post Office and Treasury Appropriation bill now being considered by that body.

Great Lakes–St. Lawrence Deep Waterway Treaty

A recent exchange of notes between the Secretary of State and the Canadian Minister has served to clarify the provisions of the Great Lakes–St. Lawrence Deep Waterway Treaty, in connection with the use of water by private enterprise on the American side. This correspondence indicated the agreement of the two governments to the effect that the terms of the treaty do not commit the United States or the State of New York to the continuance of the diversion for the private power installation now using the Massena Canal and the Grass River.

Information recently obtained from the office of the Senate Foreign Relations Committee is to the effect that the subcommittee which has been considering this treaty has not yet reported to the full committee and that there is very little likelihood that the treaty will receive consideration during the present session of Congress.

Public Utilities Census

The Bureau of the Census has indicated that the most comprehensive survey of the public utility industry ever undertaken by the Government will be made by the Department of Commerce in connection with its quinquennial census for the year 1932 of the electric light and power, electric railway, and telephone, telegraph, and wireless enterprises. Despite reductions in appropriations which will require the gathering of necessary data without the aid of field personnel, the bureau hopes to complete its canvass by July 1.

ITEMS OF INTEREST

Engineering Events in Brief

Civil Engineering for April

ARIZONA has a law which requires the state to supervise the design and construction of dams. A code on dams was prepared by the State Engineer and adopted as official in October 1932, as a guide in the safe construction of these structures. For the purpose of presenting the principles involved, J. A. Fraps, Assoc. M. Am. Soc. C.E., has prepared for CIVIL ENGINEERING a résumé of the rather lengthy code. The first of two articles on it will be found in the April issue. The importance of such a code will be recognized and should form the basis of profitable discussion.

In Greece, the River Axios has for centuries past been extending its delta out into the Gulf of Salonika. By 100 B.C. the delta had so encroached on the gulf that a part of that body was cut off and formed an inland lake, now known as Lake Yenitsa. The delta still grows and now threatens to place the seaport of Salonika on another landlocked body of water. This and the other rivers in the vicinity are flashy in character and have slowly built the level of their beds above the surrounding country. During high water, banks are broken, causing extensive floods and reducing thousands of acres of fertile and otherwise useful agricultural land to mosquito infested swamps. In 1925 the Greek government decided to reclaim these lands for settlers and made a contract with an American firm, The Foundation Company, for the work. The construction of this great reclamation project, estimated to cost $18,000,000 and now about two-thirds complete, will be described in the April issue by Ralph H. Chambers, M. Am. Soc. C.E.

Sanitary engineers and operators of filtration plants will be interested in the results of an 18-month parallel test on three different types of filtering material handling the same sewage. After such a series of tests were run at the New Jersey Sewage Research Station, samples from each 1-ft layer of each filter were taken, the retained solids measured, and complete analyses made. The methods of conducting the tests, together with the results and conclusions obtained, will be given in an authoritative article by Willem Rudolfs, M. Am. Soc. C.E., and Noel S. Chamberlin.

In developing a pressure cell for installation under the foundations of buildings, for the purpose of measuring soil pressures during extended periods of time, tests were conducted at the California Institute of Technology by Frederick J. Converse, Assoc. M. Am. Soc. C.E., on a concrete test footing 3 ft square. Enough readings under the loaded footing were taken to plot iso-pressure lines at two different load concentrations. The shape of the iso-pressure lines and the actual distribution of the soil pressure indicate clearly that the footing did not distribute the load uniformly to the soil.

Another interesting article to appear in the April issue concerns the difficulties of engineering construction in Palestine, where it took seven months to get a Y-level on the job from the manufacturer, and where even 20-in. I-beams had to be built up of second-hand plates and angles. It is a record of the experiences of Julius Lasker, who had charge of the design and construction of the Haifa Business Center and the repairs to the Hebrew University on Mount Scopus, which was damaged by earthquake.

Tests conducted in Georgia on reinforced concrete highway bridges of the slab and girder type, by Searcy B. Slack, M. Am. Soc. C.E., indicated that the stresses due to normal differences in temperature are very great. Both deflections of members and strain-gage measurements on the reinforcing steel showed that the stresses in the steel due to variation in temperature were more than twice as much as those produced by a 21,000-lb truck on the bridge. In the article by Mr. Slack, to appear in the forthcoming issue, attention is called to the necessity of evaluating these temperature stresses as they occur in unsymmetrical concrete sections.

An article by H. S. Haworth, Assoc. M. Am. Soc. C.E., will describe the construction of a reinforced brick masonry building for the Standard Oil Company of Indiana at Wood River, Ill. The 4-in. walls were reinforced with two $^3/_8$-in. horizontal bars in every third mortar joint. Special bars at columns, over windows, and at corners, provide for the stresses at these points. This type of construction, says Mr. Haworth, can be expected to become quite general in industrial work because of its economy and good appearance.

Commemorating a Notable Suspension Bridge

WITH THE FEBRUARY issue of PROCEEDINGS, the Society, in conjunction with the Port of New York Authority, has been privileged to complete an unusual series of papers. The subject itself, the famous George Washington Bridge, is unique. In size, in conception, in importance, it ranks with the famous engineering works of all ages.

It is therefore fortunate that a complete description of this work in all its many phases could be gathered together serially in one publication. In effect, this group of papers constitutes a well rounded engineering treatment of the longest single span in history. The fact that the several descriptions are by the men who were intimately connected with the work described, lends accuracy as well as authority to the entire group of papers.

During the coming months, discussions on all these papers will be received. It is expected that these will be accommodated in PROCEEDINGS during the spring months so that the entire paper, with discussions, may appear in the 1933 issue of TRANSACTIONS. There the papers will be grouped together in the same volume, in a form that will provide a complete picture of the bridge in all its aspects.

Judging from the favorable comments that have come from members, the Society as a whole is greatly indebted to the Port Authority and its engineers for the privilege of disseminating such valuable information. These papers, no less than the structure they describe, mark an epoch in engineering thought and accomplishment.

Early Navigation Lock

THE INVENTION of locks as an aid to navigation has been attributed by some to Italian engineers and by others to the Dutch. An early record gives credit to two Italians, the brothers Domenico, for the construction in 1481 of a lock chamber enclosed by a pair of gates. It is known that Leonardo da Vinci built six locks in the canals of Milan about 1487, but details of their construction are not readily available.

On the page of special interest at the front of this issue is a reproduction of an excellent woodcut taken from an early Italian illustrated book of mechanical devices published in 1607 by Zonca, who styled himself "City Architect of Padua." Apart from some inconsistencies that may be attributed to the artist, the general scheme of construction is remarkably like that of today.

The features of the design, as explained in the text, are the hand-operated windlasses for moving the main gates and a "small gate" about 3 ft square, in the lower corner of each main gate, to be used to equalize the water level on both sides of the main gate before it is opened. These "small gates" were of two designs, but the most satisfactory type was hung on a vertical peg of iron through its center, like a modern butterfly valve, and was operated by a separate chain and small hand windlass. The upper gate of the lock chamber is shown in two parts, evidently to be closed in the form of a triangle, similar to the modern miter gate. Careful framing and diagonal bracing kept sagging and swelling of the wood from preventing the closing of the gate.

In the drawing, the principal parts of the structure are lettered and described as follows:

A. Basin or chamber large enough to accommodate several boats during pas-

sage, which may be in either rectangular or in oval form.

B. Upper gate, in two parts, in the form of a triangle.
C. Lower gate.
D. Windlass of lower gate.
E. Winch of upper gate.
F. Rods or manual drive levers.

A copy of the book from which this woodcut is taken, *Novo Teatro di Machine et Edificii per Varie et Sicure Operationi*, is in the Engineering Societies Library, in New York, and is catalogued as "rare." The Italian is difficult to translate, but the typography is clear and legible.

Requests for Civil Engineering Cuts Filled

READERS HAVE MADE a very enthusiastic and gratifying response to the suggestion made in the January 1933 issue, offering on behalf of the Society to forward on request the halftone and linecut blocks used in Vol. 1 of CIVIL ENGINEERING. The only charge made for this service was the payment of postage on the cuts.

In all, 276 cuts were in demand, this number including only 44 duplicate requests, so it was possible to fill orders for the generous number of 232 cuts. Authors, of course, were given priority of choice as regards the cuts in their articles. After that, requests were filled in the order in which they were received. Cuts for which no requests were received have been destroyed.

It is interesting to note that several of the most appreciative recipients of these cuts were Student Chapter members who expect to reproduce them in student publications or make other educational use of them. The only "string" attached to any use of cuts is the requirement that the customary acknowledgment to CIVIL ENGINEERING be made when they are reprinted. If quotations from text are also used, it is necessary to give the name of the author and the issue in which the article appeared.

It is evident that it will not be possible to consider any further requests for this material. It should be observed, however, that numerous cuts from the 1932 list, Vol. 2, are still in circulation, for use in reprinting articles from the more recent issues of CIVIL ENGINEERING.

Beware of a Confidence Man

AS IS PERHAPS to be expected in an association of professional men, any one slightly versed in a few technical features of more or less common knowledge, may be able to work to his own advantage on the credulity and sympathy of honest men. Numerous cases have been called to the attention of members in these columns. The latest unfortunate experience is recounted by the Engineers Club of Philadelphia and refers to a man giving the name, R. A. Fisher or Harland Curtis.

He had a glib tongue and a plausible story. He recounted various experiences in the Middle West which lent credibility to his assertion that he was particularly qualified to cooperate to advantage in work connected with the Reconstruction Finance Corporation. For this reason he desired to make connections with outstanding consulting engineers, of course to their great advantage.

But all this was simply preliminary to the main purpose. It led to the cashing of checks which subsequently were reported as worthless, by which time Mr. Fisher himself had disappeared to parts unknown.

In the opinion of the Engineers Club of Philadelphia, other similar associations should be forewarned to be insistent on the presentation of entirely satisfactory credentials. From Philadelphia, Mr. Fisher evidently headed west, as he was next reported in the vicinity of Wheeling, W. Va., early in February. Reports by wire of his further activities will be greatly appreciated by the Engineers Club, 1317 Spruce Street, Philadelphia, Pa.

To Celebrate Trevithick Centenary, 1771–1833

ONE OF THOSE engineering pioneers who left the world immeasurably better for his efforts was Richard Trevithick, who played such an important part in the early development of the steam locomotive. The centenary anniversary of his death occurs on April 23, 1933, and it is planned to celebrate the occasion fittingly in London. Officials of the Institution of Civil Engineers (London) are making the preparations.

It is the purpose of those in charge to make the proposed commemoration international in character. American engineers will heartily concur in this idea. It is hoped, also, that some members of the Society may find it possible to join in this auspicious event. Any who expect to be in England at the time will be informed, on request, of the details of the program.

Engineering Economics—A Review of Recent Studies

By J. P. HALLIHAN
MEMBER AMERICAN SOCIETY OF CIVIL ENGINEERS

At the request of the Construction League of the United States, Major Hallihan prepared for delivery before a League meeting at Detroit on January 21, 1933, a summary of the views regarding public works presented at the October Meeting of the Society in Atlantic City. The reviewer added illuminating comments of his own. His paper is here presented in condensed form.

WHEN we speak of the economics of engineering in an abstract way, we envisage more or less the relation of the plan to the objective. The plan, carried out, must produce the result aimed at in consonance with fundamental physical and social laws. When we apply the term to a specific thing to be done, we want to know at once whether the end is going to justify the means. Waste is anathema.

What we have to consider today is not a waste of men, materials, or money on the construction of a bridge, a building, or a road. It is the economic waste of a nation in idleness.

For nearly three years, one-fourth of the nation's force of 44 million workers have been unable to find gainful employment. As this situation has continued, the reserves accumulated and pledged for investment in homes, in life insurance, in education, in the future well-being of our children, have disappeared. With each addition to the ranks of the unemployed has come an accelerated loss of purchasing power and a consequent further erosion of the foundations of the social and commercial structure.

Looking at the situation from the broad viewpoint of engineering economics, it is evident that there must be something fundamentally wrong either with the plan or the methods of execution, or both. We were just now building a nation and here is a part of the work drifting away, disintegrating faster than we can protect it. What is the cause? Has there been an uneven distribution of forces, a lack of correlation of effort? Have the component parts been erected independently of each other without the interconnections that ensure their stability and enable them to function as a whole?

These questions were discussed at length in the forum of the Society at its Atlantic City Meeting last October, at which the speakers agreed that a basic fault exists in both private and public industry in the lack of long-term planning. They criticized sharply the use of America's excess income for foreign loans, which stimulated our export trade only while the borrowed money was being spent in construction of plants to produce goods to enter the market in competition with our products. The inference drawn is that this beneficence is on a par with financing a loser to reenter a poker game. Instead, they maintained, our excess earnings as a nation should be invested in useful and necessary public works, in the creation of public wealth to better the standards of living of all the people.

In this opinion they are not far away from the famous dictum of Theodore Roosevelt, in answer to a seeker of special privilege, that we cannot make this country good enough for some of us to live in until we make it good enough for all of us to live in.

It is not to be assumed from this statement that foreign loans are condemned for governmental public works assisting the development of American trade as long as adequate security is provided and measures are taken to see that the proceeds are used for the agreed purposes. It has been pointed out in a report of the Com-

mittee on Foreign Loans, of the American Institute of Consulting Engineers, made up of members experienced in the development of foreign projects, that the severe losses incurred by American investors in recent years, contributing largely to our present difficulties, have been due to the failure of American bankers to surround foreign loans with the same safeguards demanded and enforced by European bankers, who accept the banking responsibility of protecting their clients. No issuing house in any financial center of Europe could continue in business if it failed to verify conditions by reports from independent sources before the offer of securities to the public, nor to make provision for adequate supervision of the use of the proceeds and for continuing independent annual reports on the legal, financial, and physical status of the property.

Judging by the opinions developed at the October Meeting, those engineer analysts who have scrutinized the present situation regard the nation as a bruised and beaten giant struggling to rise to his knees and resume the fight. They offer him the resumption of activity in public works as a first aid to put him on his feet, but warn him that as soon as he gets back his strength he must proceed to budget his income and construct a new road to economic progress.

One of the results that has come from all this delving into first causes and seeking of permanent remedies is the awakening of the interest of the citizen in his government—local, state, and Federal.

In this generation, at least, more attention will be paid to the interest of the community, the state, and the nation as a whole, and the seeker of unfair advantage is likely to find the going more difficult than in the past. Much progress will have been made if capital expenditures on long-term programs can be considered from the economic viewpoint of the public need and differentiated from the current cost of operating the government as a political entity. Putting the fundamental services on a utility basis, where they will be able to account for themselves through user payment and specific benefit to private property, instead of enshrouding them in the mists of general taxation, will help convince the citizen that the services he demands cannot be furnished by merely beating a gong at the crossroads. It will convince him also of the necessity of substituting reason for caprice in the selection of the public officers who spend the public dollar.

NEWS OF ENGINEERS

From Correspondence and Society Files

HARRY S. SLOCUM, who was formerly in the employ of Viele, Blackwell and Buck, of New York, N.Y., has now accepted a position as engineer with the Appalachian Electric Power Company, of Bluefield, W.Va.

EDWARD D. MEYER has accepted the position of Superintendent of Construction for the Juul Construction Company of Hutchinson, Minn.

W. LABRY BROWN has now become associated with Brown and Fritsch, civil engineers of Evansville, Ind.

P. L. MCLAUGHLIN has resigned his position as Division Sanitary Engineer for the Federal Water Service Corporation of Massillon, Ohio, to enter the employ of the West Virginia Water Service Company, with headquarters in Charleston, W.Va.

K. E. KIRBY, formerly connected with the Union Terminal Company in Dallas, Tex., has accepted the position of Assistant Engineer for the Gulf, Colorado and Santa Fe Railway Company. His headquarters are in Galveston.

ABNER J. VERNON, who was formerly employed by Nicholas S. Hill, Jr., New York, N.Y., in the capacity of Assistant Engineer, has now accepted a connection with the New Jersey State Highway Department.

R. T. REGESTER has accepted the position of Senior Designing Engineer, Division of Sewage Disposal, City of Columbus, Ohio. Prior to that he was Designing Engineer for the Division of Engineering and Construction of the same city.

KENNERLEY BRYAN, JR., formerly Managing and Contracting Engineer for the Fritz-Rumer-Cooke Company of Columbus, Ohio, has been promoted to the position of Chief Engineer of that organization.

ADELBERT A. HENDERSON has severed his connection as Construction Engineer with the Allegheny County Department of Public Works, Pittsburgh, Pa., to enter the service of the Board of Viewers of Allegheny County, with headquarters in the same city.

MARTIN K. EBY has entered the employ of the H. W. Underhill Construction Company of Wichita, Kans., in the capacity of Superintendent of Construction.

FREDERICK H. WEED has resigned as Chief Engineer of Gannett, Seelye and Fleming, of New York, N.Y., and Harrisburg, Pa. His office will temporarily be located at 25 West 43d Street, Room 1902, New York.

HAWARD P. KAY, who was formerly employed as Resident Engineer for Hawley, Freese and Nichols of Fort Worth, Tex., has now accepted a position as Assistant Engineer for the Trinityfarm Construction Company of Dallas.

ELY C. HUTCHINSON was recently elected President of the Edge Moor Iron Company, Edge Moor, Del. Prior to that he was editor of *Power*.

HERBERT A. OLSON, until lately City Engineer of Pontiac, Mich., has now accepted the position of Research Engineer for the Michigan Municipal League, with headquarters in Ann Arbor.

PHILIP J. REICH has been promoted from the position of Division Engineer of the American Bridge Company to that of Assistant Chief Engineer, with headquarters in Pittsburgh, Pa.

E. L. ERIKSEN has accepted the position of head of the Department of Engineering Mechanics of the University of Michigan, at Ann Arbor, Mich.

GEORGE H. HICKOX has become an Associate in Mechanical Engineering at the University of California, Berkeley, Calif.

C. F. GOODRICH, formerly Assistant Engineer of the American Bridge Company, New York, N.Y., has been promoted to the position of Assistant Chief Engineer of the same organization. His headquarters will continue to be the New York office of this company.

Changes in Membership Grades

Additions, Transfers, Reinstatements, Deaths, and Resignations

From January 10 to February 9, 1933, Inclusive

ADDITIONS TO MEMBERSHIP

BAKER, JAMES LEROY (Jun. '32), Care, State Highway Dept., Kerens, Tex.

BARBARIN, MARCO PARKER (Jun. '33), 57 Euclid Ave., Hastings-upon-Hudson, N.Y.

BIRKELAND, HALVARD WESSEL (Jun. '32), 5247 Twenty-First Ave., N. E., Seattle, Wash.

BLISS, PERCY HENRY (Jun. '32), R.R.3, Box 185, Vancouver, Wash.

BRAHDY, ALFRED (M. '33), Designing Engr., Board of Transportation, 250 Hudson St., New York, N.Y.

COLANTINO, THOMAS (Jun. '32), Ledgerwood Pl., Normandy Park, Morristown, N.J.

DAHLSTRAND, THOMAS OSBORN (Jun. '33), With Cleveland Wire Div., Gen. Elec. Co., Cleveland (Res., 2613 Kingston Rd., Cleveland Heights), Ohio.

ELKIN, NATHAN ELIAS (Jun. '32), 3973 Sixty-Fourth St., Woodside, N.Y.

EVANS, HENRY PRITCHARD, JR. (Jun. '33), 207 Eng. Bldg., Univ. of Iowa, Iowa City, Iowa.

GARTRELL, FRANK LEWIS (Assoc. M. '33), Asst. Engr., Div. 16, State Highway Dept., 1008 Nixon Bldg., Corpus Christi, Tex.

GORDANIER, JOHN WEDGWOOD (Jun. '32), Laboratory Asst., U.S. Bureau of Reclamation, Box 1118, Boulder City, Nev.

GRUNWELL, GILBERT BUTTERFIELD (Jun. '32), Rodman, U.S. Geological Survey, Box 1046, Punta Gorda, Fla.

HALL, WILLIAM GOLDSBOROUGH (Jun. '32), 111 Harrison St., East Orange, N.J.

HARRIS, MARK LEROY (Assoc. M. '33), Senior Engr., Jensen, Bowen & Farrell and H. E. Riggs, Michigan Theatre Bldg., Ann Arbor, Mich.

HARRIS, ROY MONTE (Assoc. M. '32), Care, T. A. Mertens, 2200 Beach St., San Francisco, Calif.

HAUSE, FREDERICK CHRISTIAN (Jun. '32), 196–05 Forty-Fifth Ave., Flushing, N.Y.

HODGES, THOMAS LAWRENCE (Jun. '32), 19 Melrose Ave., Asheville, N.C.

HOLMSTROM, HELMER AUGUST (Jun. '32), Materials Insp., State Highway Dept., Granite Falls, Minn.

HUGHES, MERVIN MARK (Jun. '32), 406 East John St., Champaign, Ill.

IRWIN, RAYMOND LEWIS (Jun. '32), Valley Forge Manor, R.D.1, Phoenixville, Pa.

KEPLEY, LEROY FRANCIS (Jun. '32), Care, State Highway Comm., Salina, Kans.

LANGER, HENRY JULIUS (Jun. '32), 2015 Bryant Ave., North, Minneapolis, Minn.

LINCK, MICHAEL KERWIN (Jun. '32), Graduate Student Asst., Syracuse Univ. (Res., 1005 First North St.), Syracuse, N.Y.

MORTON, JAMES RAYMOND, JR. (Assoc. M. '33), Designer, U.S. War Dept., Const. Quartermaster Div., Munitions Bldg. (Res., 1509 Irving St., N. W.), Washington, D.C.

PARKER, ARTHUR WILLIAM (M. '32), Capt., Q.M.C., U.S.A., Care, Quartermaster General, Washington, D.C.

PRINCE, ARCHIBALD VAN BADEN (Assoc. M. '32), Res. Engr., Mo. Pac. R.R., 1932 South Maple St., Carthage, Mo.

ROMERO, ANTONIO SILVANO (M. '32), With Public Service Comm. of Puerto Rico, 3 Washington St., Santurce, Puerto Rico.

SKIDMORE, CLAUDE FERMAN (Jun. '32), 210 South Court St., Marysville, Ohio.

SPANGLER, JOSEPH BROWNE (Assoc. M. '32), 504 Fargo, Houston, Tex.

STYLES, EDWIN BATTY (M. '33), Pres. and Treas., Styles Contr. Corporation, 35 North Dearborn St., Chicago, Ill.

SUMMERS, WAYNE (Assoc. M. '32), Sales Engr., Am. Bitumuls Co., 889 Lancaster St., Albany, N.Y.

VAN DENBURG, JOHN WALLACE (M. '33), Project Engr., Westchester County San. Sewer Comm., 312 Mamaroneck Ave., White Plains, N.Y.

WHALEN, LOUIS ALOYSIUS, JR. (Jun. '32), 233 Westminster Rd., Rochester, N.Y.

WOODS, JOSEPH MARION (Assoc. M. '33), 1913 St. Charles St., Jackson, Miss.

WOOLLEY, RALPH AYERS (Jun. '33), Draftsman, Clark County (Res., 1218 Highland Ave.), Springfield, Ohio.

WYANT, ZINT ELWIN, JR. (Jun. '33), Bridge Draftsman, State Highway Comm. (Res., 1613 Topeka Boulevard), Topeka, Kans.

MEMBERSHIP TRANSFERS

ADAM, EDWIN HEINE (Jun. '27; Assoc. M. '31), University Club, City of Mexico, Mexico.

BARTON, HARRY (Jun. '31; Assoc. M. '33), Supt. and Gen. Mgr., Pittsburgh Suburban Water Service Co., 11 Meade Ave. (Res., 654 Highland Pl.), Bellevue, Pa.

BROWN, MORRIS (Assoc. M., '20; M. '33), Pres., Keystone Eng. Co., Box 1064, Pittsburgh, Pa.

CALVIN, ELMER BEN (Jun. '29; Assoc. M., '33), Res. Engr., State Highway Dept., Fredericksburg, Tex.

EVANS, WILLIAM HAROLD (Jun. '23; Assoc. M. '33), Junior Engr., New York and Queens Elec. Light & Power Co., 40–22 Lawrence St., Flushing, N.Y.

FRICKER, FELIX OSCAR (Jun. '27; Assoc. M. '32), Asst. Engr., Quinton, Code & Hill-Leeds & Barnard, Engrs. Consolidated, 712 Standard Oil Bldg. (Res., 5320 Oakland St.), Los Angeles, Calif.

GILARDI, ADRIAN JOHN (Assoc. M. '21; M. '32), Cons. Engr., 2112 Fifth Ave., North, Seattle, Wash.

HORTON, FREEMAN HUDSON (Assoc. M. '28; M. '32), 2811 Manatee Ave., Bradenton, Fla.

MAINEY, JAMES HENRY (Jun. '31; Assoc. M. '33), Pres. and Chf. Engr., The J. H. Mainey Eng. Co., Room 1, Cleveland Trust Bldg., Painesville, Ohio.

MURPHY, GEORGE SCALLON (Jun. '28; Assoc. M. '33), Car Engr., Thomas F. Mullaney, 1639 Undercliff Ave. (Res., 605 West 187th St.), New York, N.Y.

NEGREY, STEPHEN (Assoc. M. '25; M. '33), Gen. Mgr. and Treas., Masem Constr. Co., Inc., 26 Court St., Brooklyn, N.Y. (Res., 83 Clover St., Elizabeth, N.J.)

PROUTY, WINFRED LAFAYETTE (Assoc. M. '25; M. '32), Cons. Engr. (Prouty Brothers Eng. Co.) (Res., 4585 Irving St.), Denver, Colo.

SCHERMERHORN, HARVEY OBED (Assoc. M. '10; M. '33), Asst. Chf. Engr., Div. of Eng., State Dept. of Public Works (186 West Lawrence St.), Albany, N.Y.

STAFFORD, HARLOWE MCVICKER (Jun. '16; Assoc. M. '21; M. '33), Superv. Hydr. Engr., State Dept. of Public Works, Div. of Water Resources, Box 584, Sacramento, Calif.

THATCHER, JOHN HOWARD (Jun. '29; Assoc. M. '33), Vice-Pres., John Thatcher & Son, 60 Park Ave., Brooklyn, N.Y.

VASSAR, CHARLES DAVID (Assoc. M. '23; M. '33), Architectural Engr.; Specification Writer for Charles B. Meyers, 31 Union Sq., West, New York (Res., 95 Lenox Rd., Brooklyn), N.Y.

RESIGNATIONS

ABRAHAMS, HARRY, Jun., resigned Jan. 9, '33.

AHLERS, JOHN GORDON, M., resigned Jan. 21, '33.

BACON, ROBERT HAROLD, M., resigned Jan. 10, '33.

BLEEKMAN, GEORGE MOYER, Assoc. M., resigned Jan. 16, '33.

BRUCKER, FREDERICK EMMANUEL, Jun., resigned Jan. 12, '33.

BURGESS, HARRY HOLDRIDGE, M., resigned Feb. 8, '33.

CARRICK, RICHARD SCOTT, Assoc. M., resigned Jan. 11, '33.

COTTEN, SHEPARD MARRAST, M., resigned Jan. 30, '33.

EGY, WILLARD LEO, M., resigned Feb. 6, '33.

FISH, JOSEPH THEODORE, Jun., resigned Jan. 23, '33.

FLINDT, VILHELM, Assoc. M., resigned Jan. 12, '33.

HARNED, WARREN PHILLIPS, Jun., resigned Jan. 30, '33.

HERMANNS, FRANK EDWARD, Assoc. M., resigned Jan. 20, '33.

KIST, HERMAN JACOB, Assoc. M., resigned Jan. 9, '33.

KNOWLES, JAMES HENRY, M., resigned Jan. 16, '33.

KNUDSEN, ESTHER MARIE, Jun., resigned Jan. 25, '33.

LEWIS, FREDERICK NILES, M., resigned Jan. 30, '33.

MCCAMY, ROY LEE, Jun., resigned Jan. 12, '33.

MCPHERSON, JOHN FINLAY, Assoc. M., resigned Jan. 20, '33.

MARINO, CARLOS HEDDERICH, Jun., resigned Jan. 16, '33.

MENOHER, WADE LAMONTE, Jun., resigned Jan. 9, '33.

MUNSON, LAURA AUSTIN, Jun., resigned Jan. 16, '33.

MYERS, FRANCIS MURDOCK, Jun., resigned Jan. 12, '33.

NOLEN, JOHN, M., resigned Jan. 24, '33.

OHLSEN, EDWARD HENRY, Jun., resigned Jan. 30, '33.

PAINTER, ROBERT JAMES, Jun., resigned Jan. 20, '33.

RILEY, CHARLES RUSSELL, Jun., resigned Jan. 12, '33.

RITTERSPACH, BLAIR, Jun., resigned Jan. 20, '33.

ROGERS, GEORGE EDWIN, Assoc. M., resigned Jan. 20, '33.

SCOTT, MAHLON DOUDS, Assoc. M., resigned Feb. 3, '33.

SMEAD, RALPH AMSDEN, Assoc. M., resigned Jan. 9, '33.

STAMM, NORMAN LESLIE, M., resigned Jan. 20, '33.

STEDJE, JOHN JAY, Assoc. M., resigned Jan. 19, '33.

STILES, ARTHUR ALVORD, M., resigned Jan. 12, '33.

STONE, WALTER MAXWELL, M., resigned Jan. 30, '33.

UPTON, THOMAS HAYNES, M., resigned Jan. 9, '33.

VITZ, ALVIN, Jun., resigned Jan. 20, '33.

WELLS, JAMES PARRISH, M., resigned Jan. 19, '33.

WENDLER, WALTER HUGH, Jun., resigned Feb. 6, '33.

WONDRIES, CHARLES HENRY, Assoc. M., resigned Jan. 23, '33.

YOUNG, AUBREY DEBELL, Jun., resigned Jan. 28, '33.

DEATHS

BUCK, CON MORRISON. Elected Assoc. M., Dec. 6, 1905; M., Mar. 2, 1915; died Jan. 26, 1933.

FLOYD, EARL NESBY. Elected Assoc. M., Oct. 3, 1911; M., Oct. 22, 1924; died Jan. 16, 1933.

GILMORE, DAVID PRYDE. Elected Assoc. M., June 4, 1928; died Jan. 13, 1933.

HASKELL, EUGENE ELWIN. Elected M., Sept. 7, 1898; died Jan. 28, 1933.

HENNING, HARVEY SYDNEY. Elected Jun., July 15, 1929; Assoc. M., Feb. 24, 1931; died Dec. 17, 1932.

HENRIQUES, SIMON COHEN. Elected Assoc. M., Dec. 4, 1922; died Dec. 1, 1932.

LEAHY, MAURICE JOSEPH. Elected Assoc. M., Dec. 4, 1907; M., June 4, 1913; died Jan. 27, 1933.

MAGOR, BASIL. Elected Jun., Apr. 30, 1895; Assoc. M., Mar. 7, 1900; M., Nov. 25, 1919; died Jan. 14, 1933.

MEMIJE Y VIVENCIO DEL ROSARIO, FRANCISCO XAVIER. Elected Assoc. M., Jan. 16, 1928; died Dec. 22, 1932.

SCHUERMAN, WILLIAM HENRY. Elected M., Jan. 17, 1927; died August 1932.

SKAFTE, JOHN EGON. Elected Jun., Oct. 14 1929; died Nov. 10, 1932.

WARD, PHILIP HENRY. Elected Jun., May 25, 1931; died Dec. 18, 1932.

WEBSTER, WILLIAM RICHARDSON. Elected M., Apr. 5, 1899; died Jan. 11, 1933.

WESTON, CHARLES VALENTINE. Elected M., Sept. 5, 1900; died January 27, 1933.

WILLIAMSON, PAUL REVERE. Elected Assoc. M., Jan. 15, 1923; died June 1932.

TOTAL MEMBERSHIP AS OF FEBRUARY 9, 1933

Members	5,810
Associate Members	6,315
Corporate Members	12,125
Honorary Members	19
Juniors	2,953
Affiliates	115
Fellows	5
Total	15,217

Men Available

These items are from information furnished by the Engineering Societies Employment Service, with offices in Chicago, New York, and San Francisco. The Service is available to all members of the contributing societies. A complete statement of the procedure, the location of offices, and the fee is to be found on page 97 of the 1932 Year Book of the Society. To expedite publication, notices should be sent direct to the Employment Service, 31 West 39th Street, New York, N.Y. Employers should address replies to the key number, care of the New York office, unless the word Chicago or San Francisco follows the key number, when the reply should be sent to the office designated.

Construction

CONSTRUCTION ENGINEER: Assoc. M. Am. Soc. C.E.; 37; married; professional engineer, land surveyor, New York; registered Municipal, Highway, and Structural Engineer, Florida; 16 years experience on design, estimates, and construction; highways, bridges, buildings, water systems, sewerage systems, and sewage-treatment plants. Recently completed construction of one of largest activated-sludge sewage-treatment plants in East. Available. B-7394.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 28; field experience as engineer and superintendent in excavation and foundations, also building construction on private and U.S. Government projects, including office buildings, hotels, theaters, apartment houses, postoffice, and barracks, with large metropolitan companies and National Surety. Available upon short notice. C-3233.

Design

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 28; married; C.E. degree from Polytechnic Institute of Brooklyn; special course in structural engineering; 9½ years practical experience in structural steel design for subways, piers, pier sheds, tunnels, buildings in railroad yards, and elevated structures. Checker of shop drawings; excellent draftsman. Available immediately. Location anywhere. D-1754.

CIVIL ENGINEER; Assoc. M. Am. Soc. C.E.; 37; married; graduate, state licenses; 10 years experience on surveying, design, and construction; railroad, highway, parkway, harbor, and tall building projects. Completely familiar with design of rigid-frame bridges, reinforced concrete or steel, single or multiple span, square or skew. Available immediately. D-1496.

MUNICIPAL ENGINEER; Jun. Am. Soc. C.E.; 29; married; graduate of Lehigh University; 8½ years experience on surveys, design, estimates, and construction of municipal and private engineering projects. Special work on design of sanitary and storm sewers, small sewage treatment works, and water-front improvements. Capacity for detail. Good references. Position desired with consultant or contractor. D-1400.

PULP AND PAPER MILL DESIGN AND CONSTRUCTION; Assoc. M. Am. Soc. C.E.; 34; married; graduate civil engineer (4-year course completed in 3 years); 8 years of varied experience in structural and pulp and paper mill engineering in office and field. Location anywhere. Speaks Russian fluently. Naturalized. D-119.

STRUCTURAL DESIGNER AND SALESMAN; M. Am. Soc. C.E.; 39; married; graduate C.E.; licensed; 18 years experience in structural designing, managing steel fabricating plant, and selling. Last 8 years head of consulting engineering office, specializing in structural designing for architects, owners, and contractors. Large acquaintance among architects and contractors in northern New Jersey. A-5489.

GRADUATE CIVIL ENGINEER; Assoc. M. Am. Soc. C.E.; 8 years varied structural experience; drafting, design, and construction; inspection, surveys, layouts, checking, estimating, and related work. Capacity to assume responsibility. Desires temporary or permanent connection preferably with construction company, consultant architect, builder, or contractor; also instructorship. C-2605.

STRUCTURAL ENGINEER; Assoc. M. Am. Soc. C.E.; 30; married; graduate C.E.; licensed professional engineer and surveyor; 10 years of experience; 8 years with consulting engineer—2 years in charge—designing and detailing fixed and movable bridges, particularly vertical-lift; structural design for architects; excellent draftsman. Desires any suitable connection. Salary secondary. D-506.

CIVIL ENGINEER; Assoc. M. Am. Soc. C.E.; graduate C.E.; 19 years of diversified experience with nationally known organizations. Experience includes survey work, design and details of structural steel and reinforced concrete, plant layout, machinery location and details, elevators, conveyors, transmission, etc. Accurate. Reliable. Available immediately. D-1028.

GRADUATE CIVIL ENGINEER; Assoc. M. Am. Soc. C.E.; married; 2 years of detailing and checking structural steel; 5 years in design of railroad structures; 5 years in design and charge of designing steel, concrete, and timber mine structures; 10 years, reports, estimating, design and charge of same on subaqueous tunnels. Available immediately. D-1855.

Executive

INDUSTRIAL ENGINEER; M. Am. Soc. C.E.; graduate; 15 years experience. Design and fabrication of structural steelwork. Design and construction of industrial plants, chemical plants, and hydro-electric and steam power plants. In full charge of drafting room, writing specifications for all kinds of construction materials and equipment, obtaining bids, and purchasing. B-2835.

EXECUTIVE ENGINEER; M. Am. Soc. C.E.; 37; university graduate; 15 years experience on large developments, chiefly hydro-electric. Estimates, organizing and planting, and general management construction, foreign and domestic. Location immaterial, but is interested in foreign work requiring careful planning for speed and cost. Also, preliminary investigations, designs, and reports. Available immediately. C-9694.

HIGHWAY ENGINEER; Assoc. M. Am. Soc. C.E.; graduate in civil engineering; Florida license; 7 years with U.S. War Department; 14 years as chief engineer on large county paving program. Experience includes heavy earthwork; also protection of timber structures from marine borer action. Available for work in any capacity. Location in the South preferred but will go anywhere. D-1892.

CIVIL ENGINEER; Assoc. M. Am. Soc. C.E.; 39; married; college graduate; 16 years experience, field and office; railroad, highway construction, drainage; last 10 years on tunnel and New York City subway projects; inspection on construction; surveys; field office engineer; drafting, computing, and estimating; responsible charge of all estimates. Now available. D-1858.

HYDRAULIC ENGINEER; M. Am. Soc. C.E.; 20 years experience in structural design, all phases of hydro-electric power engineering, including preliminary studies, writing reports, specifications, contracts, final design, and supervision. During past 5 years has had charge of engineering work on developments aggregating over 250,000 hp, involving dams, storage reservoirs, tunnels, and surge tanks. Location in the East preferred. D-1853.

PAPER MILL AND POWER ENGINEER; Assoc. M. Am. Soc. C.E.; 16 years experience in design, construction, economic studies, and reports. Experienced in all phases of hydro-electric and paper mill development, from financial planning to completion. Has made reports on prospective and existing plants. D-1878.

SANITARY ENGINEER; Assoc. M. Am. Soc. C.E.; 35; married; graduate of Pennsylvania State College; registered professional engineer, Pennsylvania; 6 years with State Department of Health; 7 years with nationally known consulting sanitary engineers on design, construction, and operation of water works and sewerage projects, also reports and valuations. Location immaterial. D-540.

STRUCTURAL STEEL; Assoc. M. Am. Soc. C.E.; married. A structural engineer with a long and successful record is looking for a responsible position. Experienced in designing, estimating, and selling structural steel for buildings. Graduate of Massachusetts Institute of Technology. C-9005.

GRADUATE CIVIL ENGINEER; Assoc. M. Am. Soc. C.E.; Member A.S.M.E.; married; 38; native born; 17 years with last employer in responsible capacities on pulp, paper, and hydro-electric plant design and construction. Wants job in brewing or other industry requiring vigorous personal application and high sense of responsibility. Location anywhere. Salary moderate, provided future opportunity is bright. Available now. D-1915.

ENGINEER; M. Am. Soc. C.E.; member A.S.M.E.; with broad experience in civil and mechanical engineering in New England and the South, both field and office work. Executive and sales experience. Located at present in New York. Would like interview. D-1909.

REINFORCED CONCRETE ENGINEER AND CONCRETE TECHNICIAN; Jun. Am. Soc. C.E.; 32; married; B.S. in C.E.; 10 years experience in design and construction of pavements, bridges, and buildings. Concrete control, sales promotion, office management. Desires position with architect, engineer, contractor, or as cement manufacturer's field engineer. Available immediately. D-1926.

GRADUATE CIVIL ENGINEER; Assoc. M. Am. Soc. C.E.; married; licensed New York State; 19 years experience, field and office, in all phases of engineering work; past 10 years as chief engineer for building products manufacturing company. Competent executive, designer, estimator, detailer, production manager, sales promoter, organizer. Immediately available for responsible position. Location immaterial. D-1883.

CIVIL ENGINEER; Assoc. M. Am. Soc. C.E.; 33; married; technical graduate; 16 years experience in structural and mechanical design and maintenance of chemical plants and sugar mills. Speaks Spanish. Desires position in office or plant. Available at once. Location immaterial. B-5372.

PRACTICAL ENGINEER; M. Am. Soc. C.E.; with wide and varied experience in engineering offices, field and shops, desires a position requiring initiative and ability to get things done, the position desired being one similar to that of plant engineer or master mechanic, with industrial manufacturing plant. Steel rolling mills and oil refineries most logical possibilities. C-5569.

CIVIL ENGINEER; Assoc. M. Am. Soc. C.E.; 31; married; B.S.; B.S; in C.E.; first-class Wisconsin registration; 11 years varied experience includes teaching structural engineering, surveys, design and construction of highways and bridges, industrial plants, steam and hydro-electric power, river regulation, and drainage. Available about March 15. Location immaterial. C-8715.

CIVIL ENGINEER; Assoc. M. Am. Soc. C.E.; 41; married; technical education; 20 years broad experience on structural and hydro-electric work, general engineering reports, appraisals, and investigations. Hydro-electric work includes developments and redevelopments of projects, totaling 700,000 hp. Qualified to take responsible charge of engineering projects, investigations, and reports. Location and salary open. B-172.

CIVIL ENGINEER; Assoc. M. Am. Soc. C.E.; licensed professional engineer, New York State; 25 years experience in design and construction of steam and hydro-electric power plants, transmission lines of all capacities, including 220,000 volts, industrial plants, electric railways, valuations, estimates, specifications, and purchasing. Desires responsible charge of work. Location New York. B-5423.

CIVIL ENGINEER; Assoc. M. Am. Soc. C.E.; 30 years experience, chiefly specializing in food markets, cold storage, and refrigeration; has had considerable experience as general manager for sales division of electric refrigerators, domestic and commercial. D-1516.

EXECUTIVE GRADUATE ENGINEER; M. Am. Soc. C.E.; 47; registered; member of national societies; 25 years experience in design, construction, operation; sewerage, sewage disposal, water supply, municipal, and industrial fields. Location immaterial. Salary open. C-5921.

JUNIOR

ENGINEER; Jun. Am. Soc. C.E.; 25; married; recent graduate of general civil engineering course at University of Nevada. Available immediately. No preference. D-1903-332-A-1, San Francisco.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 26; married; graduate; B.S. in C.E., with structural major; surveying experience; 3 years of drafting experience with structural steel fabricator; estimating, layout, and detail work; desires position in engineering or construction work. Location immaterial. Available immediately. D-1904.

GRADUATE CIVIL ENGINEER; Jun. Am. Soc. C.E.; 25; married; graduate of Cornell University, with C.E. degree; 1 year of experience as transitman and assistant engineer in theater and office building construction for general contractor, Rockefeller Center, New York City. Will do anything. Location immaterial. Available immediately. D-1852.

CIVIL AND STRUCTURAL ENGINEER; Jun. Am. Soc. C.E.; 26; C.E. and D. Eng., structural engineer, Rensselaer Polytechnic Institute; 3 summers on railroad surveying; summer on structural detailing; summer on calculation of properties of structural shapes. Excellent technical preparation; intelligent; accurate; industrious. Prefers position in design, research, drafting, or teaching. Will consider anything. Location immaterial. Salary secondary. C-9229.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 26; single; B.S. in C.E., Rutgers University, 1930; 1½ years as transitman in the Essex County Highway Department; passed New Jersey State Civil Service senior draftsman examination. Desires work or teaching position in any branch of civil engineering, preferably one involving mathematics. D-663.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 27; single; B.S. in C.E., Worcester Polytechnic Institute, 1927; 8 months municipal engineering in Massachusetts; 5 years highway engineering in Iowa, including plant and slab inspection on concrete pavements, preliminary surveys, drafting of plans, and road design. References. Location immaterial. Need work. D-1841.

GRADUATE CIVIL ENGINEER; Jun. Am. Soc. C.E.; 26; single; B.S. in C.E., Purdue University (sanitary engineering option); 3 months in subdivision work; 5 months on pipe-line surveys; 7 months as testing inspector and recorder on highway work. Desires position in any branch of civil engineering. Location immaterial. Immediately available. D-1830.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 25; graduate of Worcester Polytechnic Institute, 1932; 1½ years experience in surveying, drafting, and computing on highways, parks, and parkways. Wants position in any branch of civil engineering. Willing worker. References. Location immaterial. C-6231.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 26; B.S. in C.E. and C.E., College of City of New York; 4 years experience on highway work, drafting, subsurface, sewers, tunnels, estimating, inspection, topography, and setting steel and concrete forms. Licensed surveyor car and transit. Any kind of construction or development work. Available immediately. Location immaterial. D-1910.

JUNIOR TOPOGRAPHIC ENGINEER; Jun. Am. Soc. C.E.; married; B.C.E., Ohio State University; 2½ years as topographic engineer for U.S. Geological Survey; 1 summer drafting in county office; 9 months in responsible charge of topographic parties. Willing to travel. References. D-1920.

ENGINEER; Jun. Am. Soc. C.E.; 26; single; graduate of New York University, 1930; 1 year of experience on Holland Tunnel; 2½ years as assistant engineer for general contractor on subriver tunnels; draftsman; chief of party; hydrographic surveys, soundings, all necessary studies. Estimating, computing steel, concrete, waterproofing, etc. Building inspection reports; electric welding supervision; studies on settlement of buildings. Desires work with contractor. D-1921.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; single; 28; graduate of University of Illinois, Tau Beta Pi; 5 months on railroad surveying; 9 months on field-inspection paving; 4 years on highway bridge design. Wants job. Salary, location, and type of work immaterial, although field work with some traveling is preferred. D-244.

JUNIOR ENGINEER; Jun. Am. Soc. C.E.; 24; B.S. in E., 1929; C.E., 1930. Formerly assistant field instructor in surveying; field engineer on New York State highways; computer and field engineer on subway construction, 3 years. Second year of studying architectural design. Will take anything, but metropolitan area preferred. C-8128.

SALES

STRUCTURAL SALES ENGINEER; M. Am. Soc. C.E.; 45; married. Thoroughly familiar with all phases of steel fabricating business and sales generally. Over 20 years of continuous experience with leading steel companies in western Pennsylvania and Ohio districts. Exceptional sales record. Available immediately. C-5095.

SALES ENGINEER; Assoc. M. Am. Soc. C.E.; 46; 6 years of structural engineering; 18 years of sales and contracting, steel plate work. Familiar with petroleum, utility, hydraulic, and chemical fields. Has had responsible charge of sales office. Desires New York representation of superior product. D-1928.

TEACHING

STRUCTURAL ENGINEER; Assoc. M. Am. Soc. C.E.; unmarried; 30; undergraduate and graduate degrees in mathematics and engineering from leading universities; 6 years experience on the design of all types of structures, steel and concrete. Desires position with construction engineer or architect or to teach structural engineering, applied mechanics, physics, or mathematics. D-1860.

ASSOCIATE PROFESSOR OF STRUCTURAL ENGINEERING; Assoc. M. Am. Soc. C.E.; married; degrees B.S., M.S., and C.E., University of Illinois; 3 years experience teaching major courses, structural theory, and design in ranking university; 5 years practice, reinforced concrete and steel structures—chiefly Waddell and Hardesty, consultants—cantilever, arch, suspension, movable, continuous-girder spans; technical writer; world-traveller. Desires position, leading university. D-330.

SANITARY ENGINEER; Jun. Am. Soc. C.E.; 26; single; M.S. in sanitary engineering, Harvard University; 1 year as instructor, sanitary engineering; 2½ years with consulting engineers on location, design, and construction of large pipe lines. Additional experience on highways, sewers, and dams. Desires position on design, construction, or operation of civil or sanitary works. Available anywhere, immediately. D-1922.

RECENT BOOKS

New books of interest to Civil Engineers, recently donated by the publishers to the Engineering Societies Library, will be found listed here. A comprehensive statement regarding the service which the Library makes available to members is to be found on page 87 of the Year Book for 1932. The statements made regarding the books are taken from the books themselves and this Society is not responsible for them.

DESIGN OF STEEL MILL BUILDINGS AND THE CALCULATION OF STRESSES IN FRAMED STRUCTURES. By M. S. Ketchum. 5 ed. New York and London, McGraw-Hill Book Company, 1932. 632 pp., diagrs., charts, tables, 9 × 6 in., cloth, $6.

This book occupies a middle ground between elementary books on stresses and more elaborate treatises on bridge design. Although the book is chiefly concerned with mill buildings, much of it is applicable to all classes of steel-frame construction. In the present edition, the specifications have been modernized; designs for a research building, a hangar, and an air dock have been added; and a chapter upon the calculation of stresses in stiff frames by moment distribution has been included.

FARM AND VILLAGE HOUSING, REPORT OF COMMITTEE ON FARM AND VILLAGE HOUSING. Edited by J. M. Gries and J. Ford. Washington, D.C., The President's Conference on Home Building and Home Ownership, 1932. 293 pp., illus., diagrs., charts, maps, tables, 9 × 6 in., cloth, $1.15 postage prepaid.

This study is based upon a nation-wide survey of the housing situation, of financing practices, and of taxation difficulties, and of the agencies available for the improvement of conditions.

FOUNDATIONS. By S. Baker and A. De Groot. Scranton, Pa., International Textbook Company, 1932. 83 pp., illus., diagrs., charts, tables, 8 × 5 in., leather, $1.40.

The first section describes the preparation of foundation beds and piling practice, and the second treats of the design of spread footings. The elements of foundation work, as applied to ordinary conditions, are presented clearly and practically.

HYDRO- UND AERODYNAMIK, ROHRE, OFFENE GERINNE, ZÄHIGKEIT. (Handbuch der Experimental Physik, Bd. 4.) By Dr. L. Schiller. Leipzig, Akademische Verlagsgesellschaft, 1932. 719 pp., illus., diagrs., charts, tables, 10 × 7 in., 67 rm.

The results of modern research in the various branches of hydrodynamics and aerodynamics concerned with the flow of fluids in pipes and channels. These results, with the study of viscosities, are systematically reviewed by an authority upon each subject in the three articles that form this volume. An admirable view of research methods and results of value to all in search of basic principles is given.

HYDRODYNAMICS. By Sir H. Lamb. 6 ed. Cambridge (England) University Press; Macmillan Co., New York, 1932. 738 pp., diagrs., tables, 11 × 7 in., cloth, $12.

A new edition of Professor Lamb's classic treatise that has been revised throughout and includes much new matter. The developments of recent years are indicated.

NEW INTERNATIONAL ASSOCIATION FOR THE TESTING OF MATERIALS. FIRST COMMUNICATIONS, 1930, 4 vols. Groups A-D. Zurich, Switzerland, N.I.A.T.M., 1930. Illus., diagrs., charts, tables, 11 × 8 in., cloth, $10.

These volumes, the first published by this organization, consist of brief reports upon selected subjects of importance in connection with the testing of materials. The reports are grouped in four volumes, dealing respectively with metals, inorganic non-metallic materials, organic materials, and questions of general importance. The reports, by various authorities, are printed in English, French or German, with English summaries in all cases.

TREATISE ON SEDIMENTATION. By W. H. Twenhofel. 2 ed. Baltimore, Williams and Wilkins Company, 1932. 926 pp., illus., diagrs., charts, tables, 9 × 6 in., cloth. $8.

The second edition of this important treatise follows the plan of the first, but it has been thoroughly revised throughout and extended to include the progress of the last decade. It is the most comprehensive treatise in print.

UNTERSUCHUNGEN AN FAHRBAREN FÖRDERBÄNDERN FÜR DEN BAUBETRIEB. (Mitteilungen des Forschungsinstitus für Maschinenwesen beim Baubetrieb, Heft 4.) By M. R. Ehrt. Berlin, VDI-Verlag, 1932. 18 pp., illus., charts, tables, 12 × 8 in., paper, 4.50 rm.

A report of an investigation of the capacity, power consumption, efficiency, etc., of belt conveyors for handling sand, gravel, and concrete in building construction.

CURRENT PERIODICAL LITERATURE

Abstracts of Articles on Civil Engineering Subjects from Magazines in This Country and in Foreign Lands

Selected items from the current Civil Engineering Group of the Engineering Index Service, 29 West 39th Street, New York, N.Y. Every article indexed is on file in The Engineering Societies Library, one of the leading technical libraries of the world. Some 2,000 technical publications from 40 countries in 20 languages are received by the Library and are read, abstracted, and indexed by trained engineers. With the information given in the items which follow, you may obtain the article from your own files, from your local library, or direct from the publisher. Photoprints will be supplied by this library at the cost of reproduction, 25 cents per page, plus postage, or technical translations of the complete text may be obtained at cost.

BRIDGES

CLEVELAND, OHIO. Cleveland Again Bridges Cuyahoga Valley. *Eng. News-Rec.*, vol. 109, no. 25, 1932, pp. 747–749. Design and construction of Lorain-Carnegie Bridge of 13 cantilever truss spans 2,886 ft long; total length of bridge proper is 4,990 ft; copper-bearing silicon steel used.

CONCRETE GIRDER. Fortschritte im Bau von weitgespannten Eisenbeton-Balken-bruecken, K. Kajnal-Konyi. *Beton u Eisen*, vol. 31, no. 21, Nov. 5, 1932, pp. 325–329. Review of recent progress in construction of long-span reinforced concrete girder bridges, with special reference to highway bridges recently completed in Tunis, Morocco, and Algeria, and to reinforced concrete railroad bridges constructed on the Algiers-Oran line of the Paris-Lyons-Mediterranean railroad.

CONSTRUCTION. Old Bridge Transformed Into Modern Structure by Turning It Upside Down, L. C. Hollister. *Calif. Highways and Pub. Works*, Dec. 1932, pp. 22 and 23. On relocation of the Ridge Route between Los Angeles and Bakersfield, an abandoned bridge was moved to a new location and turned upside down, and a new 34-ft concrete floor was placed on what was once the bottom of six 80-ft plate girders.

DESIGN, PROBABILITY. Theory of Probability Applied to Bridge and Building Loadings, B. R. Leffler. *Am. Ry. Eng. Ass'n Bul.*, vol. 34, no. 349, Sept. 1932, pp. 167–172. Elementary outline of mathematical probability and its application to the design of multiple-track railroad bridges and multi-story office buildings.

FLOORS. Asphalt-Plank Bridge-Floor Construction, W. C. Brockway. *Can. Engr.*, vol. 64, no. 2, Jan. 10, 1933, pp. 9–12. Its adaptability for extending the period of usefulness of old bridges and for utilizing low-cost structures; advantage of lightness in weight; application methods.

GERMANY. Der Bau der neuen Rheinbruecke bei Ludwigshafen (Rhein)—Mannheim, R. Burger. *Bautechnik*, vol. 10, no. 45, Oct. 14, 1932, pp. 595–599. Report on loading test of new bridge; determination of bearing pressure under foundations.

HIGHWAY, DESIGN. Design of Approaches to Highway Bridges, H. Criswell. *Roads and Road Construction*, vol. 11, no. 121, Jan. 2, 1933, pp. 4–6. Comparison of past with present-day conditions; defects of alignment; defects of level. (To be continued.)

KENTUCKY. Old Timber Bridges, C. K. Allen. *Eng. News-Rec.*, vol. 109, no. 25, Dec. 22, 1932, pp. 753 and 754. Description of timber bridge, 100 years old, in service on Kentucky highway; features of similar bridge in service after 100 years on main highway at Paris, Ky.

MAINTENANCE AND REPAIR. Modern Practices in Bridge Re-Decking, W. F. Carson. *Eng. News-Rec.*, vol. 110, no. 3, Jan. 19, 1933, pp. 86 and 89. Light concrete slab and special design steel floors, combined with arc welding, used to repair and reinforce several county bridges in Pennsylvania; experience in welding wrought iron; cost data.

PIERS, REPAIR. Repairing Bridge Piers of Disintegrated Concrete, J. B. Ferguson. *Eng. News-Rec.*, vol. 110, no. 2, Jan. 12, 1933, pp. 57 and 58. Disintegration of the tops of the piers of the Potomac River Bridge at Williamsport, Md., caused by the freezing and thawing of water seeping into underground anchor-bolt holes; old concrete removed and new concrete placed under traffic; main bridge girders were carried during construction by existing floor beams assisted by beam and rod yokes; traffic was diverted to the opposite side of the structure during work.

PILES, CONCRETE. Efficient Pile-Casting Yard for Highway Bridges. *Eng. News-Rec.*, vol. 109, no. 25, Dec. 22, 1932, pp. 743–745. Yard provided to mold and handle 1,176 piles for three bridges, across Great Egg Harbor, N.Y.; features of gantry crane, with six-point grappling-bean pick-up, and of welded-steel forms; forms are vibrated during casting; bridge location and design

PONTOON. French Army Steel Pontoon Equipage, A. L. Helwig. *Military Engr.*, vol. 25, no. 139, Jan.-Feb. 1933, pp. 48 and 49. Features of pontoon and portable trestle bridges recently developed by French military engineers.

PROGRESS REPORT. Bridge Construction in 1932. *Engineer*, vol. 155, no. 4017, Jan. 6, 1933, pp. 24 and 25, 1 supp. plate. Review of such outstanding developments as Sydney Harbor, Benue, and Bangkok bridges; bridges in London.

RETAINING WALLS, MAINTENANCE AND REPAIR. Bridge and Retaining Wall Troubles, C. S. Chettoe and H. C. Adams. *Roads and Road Construction*, vol. 10, no. 118, 119, and 120, Oct. 1932, pp. 296–299, Nov., pp., 328–331, and Dec., pp. 361–363. Oct.—Troubles due to faulty design of abutments and retaining walls. Nov.—Troubles due to insufficient investigation of site and to causes which could be foreseen but not prevented, e. g., mining subsidence. Dec.—Combating tendency to sink, tilt, or slide forward; scour beneath abutments; troubles due to faulty construction.

STEEL ARCH, CONSTRUCTION. Building Bridge in Three Strips, H. C. Whitehurst. *Eng. News-Rec.*, vol. 109, no. 26, Dec. 29, 1932, pp. 784 and 785. To maintain traffic during replacement of old Klingle Valley Connecticut Avenue Bridge in Washington, D.C., section of new bridge was built complete on either side before old bridge was demolished; result is unusual spacing of arch ribs in new structure; rigid-frame treatment of rib sway-bracing and of columns and girders that support roadway.

STEEL CONSTRUCTION. Steel for Construction Shows Development During 1932, R. C. Manning. *Contract Rec.*, vol. 46, no. 52, Dec. 28, 1932, pp. 1436–1441. Increased use of Canadian-made steel; steel bridges; new bridge floor of steel; steel buildings; wider use of Kane system.

STEEL TRUSS, AUSTRALIA. Clarence River Bridge—I, J. W. Roberts. *Inst. Engrs. Australia—Journal*, vol. 4, no. 11, Nov. 1932, pp. 369–381. History and preliminary and final designs of combined steel-truss bridge over the Clarence River at Grafton, New South Wales, having a total length of 1,309 ft; maximum span 245 ft long, including bascule span 84 ft long; contact pressure between rollers and track-plates; operating bascule span. (To be continued.)

STRESSES. Stress Characteristics of Viaduct-Bents, Y. Misawa. *Civ. Eng. Soc. Japan—Journal*, vol. 18, no. 10, Oct. 1932, pp. 1095–1106. Theoretical mathematical analysis of stresses; tables and curves. (In Japanese.)

SUSPENSION, INDIA. Light Suspension Bridges, J. M. Jardine. *Indian Eng.*, vol. 92, no. 20, Nov. 12, 1932, pp. 392 and 393. Advantages of light suspension bridges in crossing rivers with shifting beds; features of suspension foot-bridge over Panchnoi River, Assam, 350 ft long.

VIADUCTS. Varied Steel-Erection Practice on New Jersey Viaduct. *Eng. News-Rec.*, vol. 110, no. 2, Jan. 12, 1933, pp. 43–48. Description of 3 miles of truss spans on the high-level structure on the Holland Tunnel approach highway in New Jersey, erected by four contractors, using different equipment and procedure; viaduct includes two 550-ft span cantilever river crossings.

WOODEN. Report of Committee VII—Wooden Bridges and Trestles. *Am. Ry. Eng. Ass'n—Bul.*, vol. 34, no. 349, Sept. 1932, pp. 65–74. Simplification of grading rules and classification of timber for railway uses; best relationships between energy of hammer and weight or mass of pile for proper pile driving, to include concrete piles; improved methods of strengthening existing bridges.

BUILDINGS

CONCRETE. Fast-Truck Concrete Haul Cuts Building Costs, W. J. Barney. *Eng. News-Rec.*, vol. 109, no. 26, Dec. 29, 1932, pp. 778–779. Construction of five scattered units, including five-story building, for Meadowbrook Hospital, in Nassau County, N.Y.; group of buildings served from central mixing plant by two small trucks with bottom-dump bodies; wood pans or cores reduce floor costs.

CITY AND REGIONAL PLANNING

PARKS. Acquisition of Park Land in Connection with Real Estate Subdivisions, S. H. Hare. *City Planning*, vol. 9, no. 1, Jan. 1933, pp. 10–14. Dedication as condition of plat approval; suggested method; value of open space recognized by subdividers; kinds of open space normally reserved; administration of small ornamental areas.

UNITED STATES. New Plan for Historic Alexandria, Virginia, I. C. Root. *City Planning*, vol. 9, no. 1, Jan. 1933, pp. 1–9. History of Alexandria, Va.; zoning and city planning ordinances; main highways and parks; school distribution and housing; rehabilitation of old Alexandria and plans for future.

CONCRETE

CONSTRUCTION. Past Year's Progress in Concrete Construction. *Contract. Rec.*, vol. 46, no. 52, Dec. 28, 1932, pp. 1434 and 1435. Introduction of European methods; long rigid-frame structures; concrete building trends.

FORMS. Sliding Form Work. *Am. Concrete Inst.—Journal*, vol. 4, no. 5, Jan. 1933, pp. 201–240. Report of Committee 608 on the use of sliding forms in concrete construction; equipment and methods; swelling of forms; raising forms from concrete; quality of sliding form concrete; possible improvements; adaptation of methods to South American conditions.

MIXING. Reduction of Concrete Costs, V. S. Wigmore. *Engineering*, vol. 135, no. 3495, Jan. 6, 1933, pp. 19 and 20. It is claimed that this method will completely satisfy the engineer and ensure that correct proportions of coarse aggregate, fine aggregate, and cement are supplied; $5^1/_2$ cu ft of sand and coarse aggregate are used with each cubic foot of cement, instead of 6 cu ft of coarse aggregate and sand allowed by specification.

READY MIXED. Test Procedure for Control of Ready-Mixed Concrete. *Concrete*, vol. 40, no. 8, Aug. 1932, pp. 20 and 21. Value of independent inspection and certification; much variation in specifications to be met; well designed plant simplifies control.

DESIGN. Deflection of Certain Rectangular Reinforced Concrete Slabs Freely Supported along Two Parallel Edges, J. F. Baker. *Concrete and Constr. Eng.*, vol. 27, no. 12, Dec. 1932, pp. 691–708. Tests on slabs under uniformly distributed loads; test of slab under central concentrated load; comparison of observed and calculated deflections; deflections before cracks appeared were very close to those of thin plates of homogeneous material similarly loaded; value of Poisson's ratio was not far from zero.

SPECIFICATIONS. Concrete Control Encouraged by Northwest Building Codes, H. M. Hadley. *Eng. News-Rec.*, vol. 110, no. 2, Jan. 12, 1933, p. 49. Portland code permits higher stresses under controlled conditions, as has been done successfully for some years in Seattle; table of working stresses allowed by new code.

CONSTRUCTION INDUSTRY

EMBANKMENTS. Jetting Solidifies Large Embankment. *Ry. Age*, vol. 94, no. 2, Jan. 14, 1933, pp. 41–43. Accelerating settlement of embankment at Cincinnati in filling-in of Mill Creek Valley for the new Cincinnati Union Terminal; analysis of fill materials; behavior of shale in fill; jetting was done with 2-in. pipe with 90-deg bend attached to standard $2^1/_2$-in. fire hose; cost 2.3 cents per cu yd.

DAMS

CONCRETE ARCH, CONSTRUCTION. Arch Dam Built in Isolated Blocks to Reduce Shrinkage Effects, F. A. Noetzli. *Eng. News-Rec.*, vol. 110, no. 3, Jan. 19, 1933, pp. 78 and 79. Construction of constant radius concrete arch dam in Grimsel Pass, Switzerland, 373 ft high; central mass of dam was built up in large columnar blocks and allowed to lose its heat of setting before intervening slots were filled; forked abutments result in a saving of concrete.

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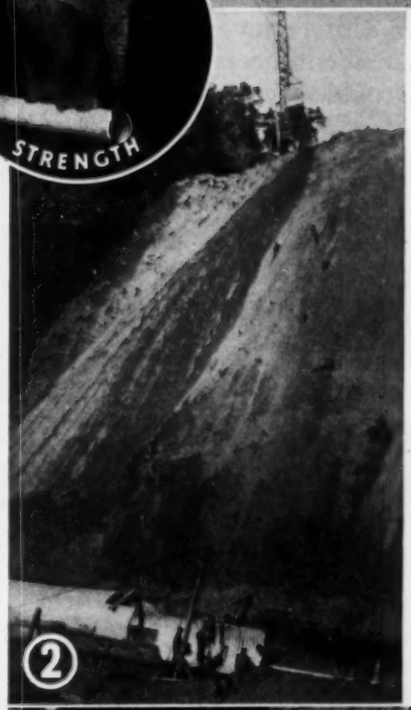

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Continued on page 10

CONCRETE GRAVITY, AUSTRALIA. Wyangala Dam. *Commonwealth Engr.*, vol. 20, no. 5, Dec. 1, 1932, pp. 131–136. Description of irrigation reservoir on Lachian River, N.S.W.—capacity 303,900 acre-ft—and curved concrete gravity dam 190 ft high; concrete spillway wall of ogee section, about 1,000 ft long, is located in depression, separated from dam by small hill; use of copper seal; hydro-electric and irrigation outlets; estimated cost of work is £1,352,000.

CONSTRUCTION. Motor Trucks Haul Material for Rock-Fill Dam. *Contractors and Engrs. Monthly*, vol. 26, no. 1, Jan. 1933, pp. 23 and 24. Operation of motor trucks in the construction of the San Gabriel Dam of the Los Angeles County Flood Control District, involving the transportation of 1,200,000 cu ft of metamorphic rock; fill consists of all sizes of rock from quarry chips to single pieces weighing over 25 tons.

COSTS. Unit Bid Summary. *West. Construction News and Highways Bldr.*, vol. 7, no. 24, Dec. 25, 1932, pp. 728, 730, and 732–733. Unit costs bid on San Gabriel Dam No. 1 of Los Angeles County Flood Control District; road and street construction in California, Utah, and Colorado, etc.

EARTH. Earth Dams, J. C. Sahney. *Indian Eng.*, vol. 92, no. 20, 21, 22, and 23, Nov. 12, 1932, p. 397, Nov. 19, pp. 414 and 415, Nov. 26, pp. 435–437, and Dec. 3, pp. 453–455. Principles of storage for irrigation purposes and of construction of earth dams, with special reference to Indian conditions, including combined rock-fill and earth dams and hydraulic-fill dams; organization of construction.

HAMILTON DAM, TEX. Building Hamilton Dam on Colorado River in Texas. *Eng. News-Rec.*, vol. 110, no. 2, Jan. 12, 1933, pp. 59–62. Development on the Colorado River in the vicinity of Burnet, Tex., including a concrete dam 8,377 ft long, combining multiple-arch and gravity types to develop a 126-ft head for three hydro-electric units of 10,000 kw; power house is located downstream from 70-ft span multiple-arch section with intakes through arch; concrete and construction plant.

HOOVER DAM PROJECT. Hoover Dam on Colorado River. *Engineer*, vol. 154, no. 4013 and 4014, Dec. 9, 1932, pp. 580–583 and Dec. 16, pp. 606–609. Particulars of project, descriptions of which have been previously indexed from various sources.

ROCK-FILL. Penrose Steel-Faced Rock-Fill Dam, Colorado. *West. Construction News and Highways Bldr.*, vol. 7, no. 24, Dec. 24, 1932, pp. 719 and 720. Feature of dam described in several previously indexed articles.

SPECIFICATIONS. Arizona Publishes Code for Guidance in Building Dams. *Eng. News-Rec.*, vol. 109, no. 26, Dec. 29, 1932, pp. 771–772. Abstract of 30,000-word building code for dams; foundations and spillways; arch dams; gravity concrete dams; earth dams; rock-fill dams.

STEEL. Composite Dams Proposed, R. W. Abbett. *Eng. News-Rec.*, vol. 110, no. 2, Jan. 12, 1933, p. 63. Discussion of paper entitled: Why Not Steel Dams? C. M. Stanley, indexed in Engineering Index 1932 from the issue of Dec. 1, 1932.

FLOOD CONTROL

UNITED STATES. Waterway and Flood-Control Activity, H. J. Casey. *Military Engr.*, vol. 25, no. 139, Jan.-Feb. 1933, pp. 55–59. Review of work of the U.S. Government through the Corps of Engineers and Engineer Department; relief to unemployment; economies effected; progress made on major projects on Atlantic Coast, Gulf Coast, Pacific Coast, Great Lakes, Ohio River, Missouri River, and the Mississippi River and its tributaries.

FOUNDATIONS

RETAINING WALLS, DESIGN. Surcharge Chart, S. Gisser. *Eng. News-Rec.*, vol. 110, no. 2, July 12, 1933, p. 63. Construction of chart which will give equivalent water pressure for any angle of surcharge and the ratio of the height of the surcharge to the height of the wall.

SOILS, PHYSICS. Soil Action Under Load Shown by Test, D. P. Krynine. *Eng. News-Rec.*, vol. 109, no. 26, Dec. 29, 1932, pp. 782–784. Movement of soil under test load disclosed by excavating vertical cut under loaded area and by observing soil movement and moisture condition; analysis of determinations; photo-elastic analogy; relation between size of loaded plate and its settlement; critical loads; eventual settlement.

HYDRAULIC ENGINEERING

HYDRAULIC MODELS. Experiments with River Models, H. D. Vogel. *Military Engr.*, vol. 25, no. 139, Jan-Feb. 1933, pp. 26–28. Review of hydraulic model testing done at the Vicksburg Laboratory in connection with studies of river improvements in the United States.

LABORATORIES, CANADA. Le nouveau Laboratoire d'Hydraulique de l'École Polytechnique, A. Circé. *Revue Trimestrielle Canadienne*, vol. 19, no. 72, Dec. 1932, pp. 347–359. Description of new hydraulic laboratory of École Polytechnique of Montreal, occupying two stories, 90 ft by 45 ft and 45 ft by 45 ft in area; equipment includes glass plate canal having a cross section of 30 in. by 30 in.

TURBINES, TESTING. Water Turbine Testing Flume of University of Toronto, R. W. Angus. *Univ. Toronto—Faculty Applied Science and Eng.—School Eng. Research—Bul.*, no. 9, 1932, pp. 129–139. Details of flume consisting of concrete tank 8 ft square at top and 7 ft 8 in. square at bottom, inside depth being 9 ft 3 in.; below bottom of tanks is concrete channel 8 ft wide, 6 ft 3 in. deep, 15 ft 8 in. long; water is supplied by pump of high-speed spiral type with 16-in. suction and 14½-in. discharge branches.

HYDRO-ELECTRIC POWER PLANTS

ITALY. Gli impianti idroelettrici della Sila, M. Mortara. *Energia Elettrica*, vol. 9, no. 11, Nov. 1932, pp. 962–1002. Description of concrete-lined tunnels from 2.5 m to 2.8 m in diameter and of concrete-lined shaft 5 m in diameter, over 50 m deep; details of penstocks and mechanical and electrical equipment of power houses; map of 60 kv and 150 kv transmission lines to Tusciano and Bari.

HYDROLOGY, METEOROLOGY, AND SEISMOGRAPHY

FLOODS, FORECASTING. Versuch einer Vorhersage rascher Pegelstandsaenderungen des Rheinstromes bei Basel, etc. *Schweiz Wasser- und Energiewirtschaft*, vol. 24, nos. 7 and 8, July 25, 1932, pp. 65–69, and Aug. 25, pp. 73–76. Report from the Central Meteorological Bureau of Switzerland on methods of forecasting rapid rise in the level of the Rhine River at Basel, on basis of precipitation reports on watershed; derivation of mathematical formula correlating rainfall with river stages.

OCEANOGRAPHY. Le pH et le rythme des marées, A. Labbé. *Académie des Sciences—CR*, vol. 195, no. 25, Dec. 19, 1932, pp. 1297–1299. Observations on fluctuations of pH value with rise and fall of tides.

SEISMOLOGY. Theory of Interpretation of Seismic Travel-Time Curves in Horizontal Structures, L. B. Slichter. *Physics*, vol. 3, no. 6, Dec. 1932, pp. 273–295. Theory is treated after the manner of Herglotz-Wiechert, under customary assumption that ray paths obey laws of geometrical optics.

STREAMS, EROSION. Geologic Work of Ice Jams in Subarctic Rivers, C. K. Wentworth. *Wash. Univ. Studies—New Series Sci. and Technology*, no. 7, Oct. 1932, pp. 49–80. Observations on processes of erosion, abrasion, transportation, and deposition incident to ice jams in rivers; features resulting from these processes in the valley of the Yukon River between Dawson, Yukon Territory, and Circle, Alaska, are compared with similar features resulting from work of glaciers; résumé of reports by earlier observers.

INLAND WATERWAYS

CANAL LOCKS, MAINTENANCE AND REPAIR. Note sur l'étanchement des écluses du Canal de l'Est et sur l'emploi en injection des mélanges ciment de laitier et ciment fondu, Antoine. *Annales des Ponts et Chaussees (Partie Technique)*, vol. 2, no. 5, Sept.-Oct. 1932, pp. 175–185. Method of repairing leaky locks of Canal de l'Est, France, by grouting with mixtures of slag cement and melted cement.

FILLING. Hydraulics of Lock-Filling Systems, G. R. Rich. *Military Engr.*, vol. 25, no. 139, Jan.-Feb. 1933, pp. 60–64. Hydraulic theory underlying calculation of short-loop Venturi filling systems, as given in Dutch Government report, *Rapporten en Mededelingen van den Rijkswaterstaat*, by J. A. Ringers and J. Jitta; long filling conduits with short laterals; non-axial flow in conduits with short laterals.

RIVERS, IMPROVEMENT. Beschouwingen Over Verbeteringswerken in Rivieren, A. S. von Banchet. *Waterstaats-Ingenieur*, vol. 20, no. 6 and 7, June 1932, pp. 169–207; and July pp. 209–217; 3 supp. plates. Report on improvements in the channel of the Djambi River in Java; hydrology of Djambi River; historical review of theory of similitude and principle of hydraulic testing with models; results of tests of model of Djambi River made at Tandjong Priok hydraulic laboratory.

IRRIGATION

INDIA. Sukkur Irrigation Project: Sind (I). *Civ. Eng. (Lond.)*, vol. 27, no. 317, Nov. 1932, pp. 12–16. Indus River as a source of irrigation water; native irrigation practice; features of Sukkur stoney gate dam, comprising sixty-six 6-ft sluiceways with gates for raising water level to a height of 17½ ft above sill. (To be continued.)

LAND RECLAMATION AND DRAINAGE

EGYPT. Reclamation Scheme for Nile Delta. *Water and Water Eng.*, vol. 34, no. 411, Dec. 20, 1932, pp. 592–596. Description of pumping plants and pumping equipment, including electric motors, for the reclamation of alkaline lands, 2,000 sq mi in area, in the district between Alexandria and Port Said, Egypt.

GREAT BRITAIN. Land Drainage in England and Wales, J. C. A. Roseveare. *Water and Water Eng.*, vol. 34, no. 412, Winter 1932, pp. 637–654 (discussion) 654 and 655. Review of legislation concerning drainage of the British Isles; organization of catchment boards; irrigation and water supply; river gaging; run-off catchment areas; River Thames and other watersheds; drainage schemes in Ireland; government grants toward land drainage works; Welmore Lake sluices; River Ouse training walls; land reclamation by embanking; sea defences. Before Instn. Water Engrs.

PUMPS, CENTRIFUGAL, DESIGN. Centrifugal Pumps for Zuyder Zee Reclamation. *Engineering*, vol. 134, no. 3494, Dec. 30, 1932, pp. 777 and 778. Results of extensive tests by the Werkspoor Company of Amsterdam, based on a report by T. Theunissen, chief engineer of the company; main problems were to obtain maximum efficiencies under various conditions of head and to avoid cavitation; experiments carried out at the University of Delft led to a number of modifications in design.

SIPHONS, ITALY. La tomba a sifone sotto il Santerno per il canale di scolo in destra di Reno, G. Monaldi. *Annali dei Lavori Pubblici*, vol. 70, no. 7, July 1932, pp. 632–640. Design and construction of triple battery of concrete siphons of ovoid section, with a total capacity of 30 cu m per sec, founded on piles and carrying the discharge of a large drainage canal under channel of Santerno which is over 100 m wide and about 10 m deep.

PORTS AND MARITIME STRUCTURES

BREAKWATERS, SWITZERLAND. Lake Zurich Breakwater Built on Piles, A. J. Luchinger. *Eng. News-Rec.*, vol. 110, no. 3, Jan. 19, 1933, pp. 80 and 81. Construction of concrete breakwater, 361 ft long, for Waeldenswil Harbor on Lake Zurich, Switzerland; structure consists of concrete box girders, submerged below wave action and carried on capped cylinder piles.

FRANCE. Construction de quais maritimes en palplanches métalliques au Port de Dunkerque, A. Delattre. *Annales des Ponts et Chaussees (Partie Technique)*, vol. 2, no. 5, Sept.-Oct. 1932, pp. 186–206. Use of steel sheet piling in construction of quay walls totaling 550 m in length, in Port of Dunkerque, France.

GREAT BRITAIN. Nottingham Dock Scheme. *Civ. Eng. (Lond.)*, vol. 27, no. 317, Nov. 1932, pp. 26 and 27 and 49. Description of project for rendering River Trent, between Nottingham and Newark, navigable at all stages of water; description of work done in port of Nottingham in connection with this project.

HAMBURG. Port of Greater Hamburg. *Naut. Gaz.*, vol. 123, no. 1, Jan. 7, 1933, pp. 7–11 and 29. Terminus of transatlantic shipping traffic and home port of the large fleet of ships trading with countries beyond the North Sea and with Scandinavian and Baltic countries; harbor installations and their equipment; Hamburg as free port; trans-shipment of goods.

MANCHESTER, ENGLAND. Port of Manchester, England. *Naut. Gaz.*, vol. 122, no. 26, Dec. 24, 1932, pp. 5–8 and 27. Principal imports are listed according to value; Port Authority is also railway company; Manchester Ship Canal; rail connections; port facilities.

QUAY WALLS, GREAT BRITAIN. River Wall in Reinforced Concrete, A. Hood. *Structural Engr.*, vol. 11 (*New Series*), no. 1, Jan. 1933, pp. 2–14. Construction of about 1,000 ft of quay wall along the river Nene at Wisbech, England; driving of reinforced concrete sheet-piling; load-testing of piles; cost data.

ROTTERDAM. Rotterdam. *Naut. Gaz.*, vol. 122, no. 25, Dec. 10, 1932, pp. 7–11. Industrial entrance to Continental Europe; development, management, and future; docks and interior waterways.

ROADS AND STREETS

BRICK. Recent Developments in Brick Paving for Municipalities, R. L. Phillips. *Am. City*, vol. 48, no. 1, Jan. 1933, pp. 55–57. Building of pavements for subgrade; use of concrete base and cushions; improvement in paving brick; asphalt fillers and their use; curb and gutter construction; resurfacing or relaying brick pavements. Before Nat. Paving Brick Ass'n.

CANADA. Eastern Link in Trans-Canada Highway, E. Newton-White. *Can. Engr.*, vol. 63, no. 3, July 19, 1932, pp. 11–14. Construction of Pembroke-North Bay section by the Department of Northern Development on unemployment relief basis.

CEMENT BOUND. Build Cement-Bound Macadam Type for Secondary Roads. *Concrete*, vol. 41, no. 1, Jan. 1933, pp. 5 and 6. Construction of five experimental sections of cement-bound macadam pavement in New Jersey, Pennsylvania, and New York at a cost of approximately $1 per sq yd; construction methods; size and kind of stone.

CONCRETE. Doncaster-Grimsby Trunk Road. *Quarry and Roadmaking*, vol. 38, no. 433, Jan. 1933, pp. 7–13. Details of a new section of highway on the Doncaster-Grimsby main trunk

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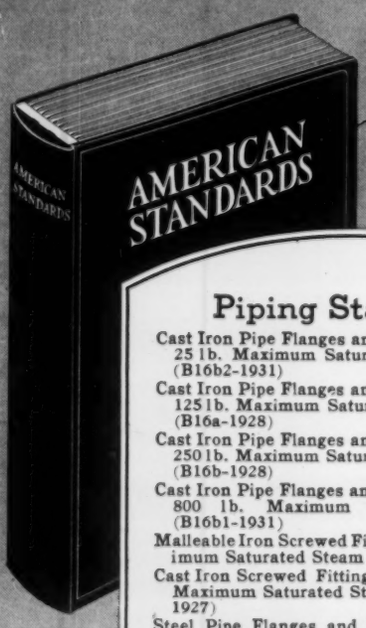

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road, 3.15 miles in length; reinforcement and joints; surface finish; camber; curbing; surface water and drainage; footpath; cost £54,000.

CURVES. Rectifying Road Curves, F. G. Royal-Dawson. *Roads and Road Construction*, vol. 11, no. 121, Jan. 2, 1933, pp. 23 and 24. Examination of the contention that there is ample margin in the width of ordinary roadway to cover the discrepancy between road alignment and the actual track of the vehicle; laying out new roads on transition principles; example of ordinary road curve; process of rectification. (To be continued.)

HIGHWAY ADMINISTRATION, NORTH CAROLINA. Centralized Road Control in North Carolina. *Eng. News-Rec.*, vol. 110, no. 3, Jan. 19, 1933, pp. 82–84. Record of year's experience of first state to take over the administration of all public roads; organization diagram of the North Carolina State Highway Commission; types of county road equipment and percentage found available and taken over by state.

ITALY. Italian Motor Roads, F. Karpeles. *Roads and Road Construction*, vol. 10, no. 120, Dec. 1, 1932, pp. 366 and 367. Description of Brescia-Bergamo motor road of total length of 45 km, of which 38 km are laid on artificial fill.

LOW COST. Building Low-Cost Base for Low-Cost Road, J. S. Crandell. *Eng. News-Rec.*, vol. 109, no. 25, Dec. 22, 1932, pp. 751 and 752. Experience of Champaign County, Ill., with construction of 3-in. tarred-stone base built on corn-belt soil, with 2½-in. retread surface, for $9,000 a mile, including $1,400 for unnecessary "depression-time" labor.

MACHINERY. Highways and Streets of Our Nation, P. J. Dasey. *Motive Power*, vol. 4, no. 1, Jan. 1933, pp. 3–13, 16, 17 and 24–27. Use and performance data of principal types of road construction machinery, including cranes, steam shovels, dredges, tractors, trucks, rollers, and grading machines.

MAINTENANCE AND REPAIR. Premixed Macadam for Road Maintenance in Australia, S. M. Brown. Roads and Road Construction, vol. 10, no. 120, Dec. 1, 1932, pp. 364 and 365. Review of early and recent methods for maintenance of non-rigid black-top pavements in the county of Cumberland. From *Main Roads*, June 1932.

MODELS. Models of Mount Vernon Memorial Highway, A. C. Rose. *Landscape Arch.*, vol. 23, no. 1, Oct. 1932, pp. 61–69. Determination of character of models; method of construction; accurate reproduction of topography; preparation of ground surface.

ROAD MATERIALS, ASPHALT. Cut-Back Asphalts for Construction of Low-Cost Roads, B. E. Gray. *Contract Rec.*, vol. 46, no. 51, Dec. 21, 1932, pp. 1405–1407. Consideration of various types of pavements that can be built or maintained with cut-backs. (To be continued.)

ROADSIDE IMPROVEMENT. Neglect of Esthetics in Planning of Rural Highways, R. Schermerhorn, Jr. *Landscape Arch.*, vol. 23, no. 1, Oct. 1932, pp. 41–46. Recommendations for safeguarding the esthetic appearance of highways.

UNITED STATES. Highway and Construction Number. *Eng. News-Rec.*, vol. 110, no. 1, Jan. 5, 1933, pp. 1–31. (2 cards—card 1.) Articles by eleven leaders in roadbuilding and construction on the major problems of the current year: Regulation of Road Business Lacks Necessary Unity, T. H. MacDonald; Road Taxes for Roads, W. C. Markham; Highway Demand Is Turning from Main to Local Roads, B. H. Petty; Paved Surfaces Unwarranted for Secondary Roads, P. Hubbard; Paved Surfaces Possible for Secondary Roads, E. M. Fleming; Surface Secondary Roads for Secondary Traffic, A. R. Taylor; Mounting Maintenance Costs Demand New Planning, L. R. Ames; Revamping Paved Road Increasing Obligation, O. W. Merrell; Road Costs and Revenues—How They Balance, P. M. Tebbs; Federal Aid Can Stabilize Highway Development, G. B. Sewers; Construction Needs Purge and Better Dietetics, H. H. Wilson.

SANITARY ENGINEERING

PROGRESS REPORT. Water Supply and Sanitary Engineering in 1932. *Engineer*, vol. 155, no. 4017, Jan. 6, 1933, pp. 25 and 26. Work in progress or completed during the year; new schemes proposed or put in hand; developments in London; West Middlesex sewage scheme; provincial schemes; undertakings outside of Great Britain.

SEWERAGE AND SEWAGE DISPOSAL

BRICK CONSTRUCTION, REINFORCED. Reinforced Brick Masonry on Dearborn Sewer System, C. H. Fork. *Eng. News—Rec.*, vol. 109, no. 25, Dec. 22, 1932, pp. 749 and 750. Use of brick, reinforced with steel rods, in the construction of a regulator chamber and dam in an old storm sewer to fit it for combined flow.

IMHOFF TANKS. Imhoff-Tank Effluent Aerated to Reduce Load on Filters, W. R. Drury. *Eng. News-Rec.*, vol. 109, no. 25, Dec. 22, 1932, p. 752. Experience of Sewage Disposal Plant of Flint, Mich.; air is collected after having passed through sewage and is used to ventilate trickling filters, thereby avoiding odors.

INDUSTRIAL WASTES. Sewage Plant Rebuilt to Treat Rayon Wastes, U. F. Turpin. *Eng. News-Rec.*, vol. 109, no. 26, Dec. 29, 1932, pp. 780–782. Experience of sewage disposal plant of Sparta, Ill.; in new activated-sludge plant grease-bearing waste from textile mill must be closely controlled; casein wastes from creamery must be entirely eliminated from sewage; operation results; 150 to 160 ppm of grease is the maximum that can be treated successfully; relatively small amounts of casein waste make it impossible to maintain activated sludge.

NORTH CAROLINA. Sewage Treatment at High Point, N.C., E. H. Moss and C. W. Mengel. *Water Works and Sewerage*, vol. 79, no. 12, Dec. 1932, pp. 433–438. Description of two sewage disposal plants serving jointly a population of 35,000; older plant, of sprinkling filter separate sludge digestion type, receives sewage highly impregnated with spent dyes and other textile wastes; new plant of activated sludge type, receives domestic sewage only; comparative operating results and cost data.

SAN ANTONIO, TEX. San Antonio Sewage Treatment Plant, W. S. Stanley. *Water Works and Sewerage*, vol. 80, no. 1, Jan. 1933, pp. 21–23. Description of a plant designed for a capacity of 30 mgd to serve a population of 400,000; primary settling and aeration tanks; final settling tanks; digestors; blower house and pumping station; cost of construction and operation.

SEWAGE DISPOSAL PLANTS, OPERATION. Apple Wastes Create Operating Difficulties in Sewage Plant, P. P. Pilcher. *Mun. Sanitation*, vol. 3, no. 12, Dec. 1932, p. 485. Experience of Winchester, Va.; Strong acid condition of sewage requires special treatment. Before Va. Water and Sewage Works Ass'n.

SEWERS, CONSTRUCTION. Building Sewers in Winter with City Welfare Labor. *Eng. News-Rec.*, vol. 110, no. 3, Jan. 19, 1933, p. 81. Methods and costs of sewer construction amounting to $300,000 carried on in Duluth largely to aid unemployed.

STRUCTURAL ENGINEERING

BRICK CONSTRUCTION, REINFORCED. History of Reinforced Brickwork, H. Filippi. *Contract. Rec.*, vol. 47, no. 3, Jan. 18, 1933, pp. 60–62. Chief engineer of the Common Brick Manufacturers' Association of America reviews the history of reinforced brickwork construction since 1813; first analysis of stresses; twentieth century developments; recent developments. Before Eng. Inst. Can.

COLUMNS, BUCKLING. Naeherungsverfahren fuer die Biegung und Knickung eines geraden Stabes bei Ueberschreiten der Eulerlast, A. Schleusner. *Stahlbau (Supp to Bautechnik)*, vol. 5, no. 20, Sept. 30, 1932, pp. 155–157. Theoretical mathematical discussion leading to derivation of method for computing bending and buckling of straight rods under conditions outside of range of Euler formula.

DESIGN. Current Trends in Structural Design, G. L. Wallace, *Contract Rec.*, vol. 46, no. 52, Dec. 28, 1932, pp. 1431–1433. Concrete construction; composite construction; masonry construction; steel construction; timber construction.

STATICALLY INDETERMINATE STRUCTURES. Derivation of Influence Equations of Statically Indeterminate Structures with Partial Fixity at Supports, T. Mikuriya. *Civ. Eng. Soc. Japan—Journal*, vol. 18, no. 11, Nov. 1932, pp. 1177–1183. Theoretical mathematical discussion with special reference to arch with various percentages of fixity at supports; numerical examples. (In English.)

WELDS, DESIGN. Principles and Practice in Welded Joint Design, G. D. Fish. *Eng. News-Rec.*, vol. 109, no. 26, Dec. 29, 1932, pp. 773–777. Balancing theoretical and practical considerations in joint analysis, with procedure and formulas for beam connections and splices, column splices, truss joints, and other details; rigid and flexible connections; semi-rigid connections; splices for girders and columns; heavy gusseted truss joints.

SURVEYING.

GEODETIC SURVEYING. U.S. Coast and Geodetic Survey. *Eng. News-Rec.*, vol. 110, no. 3, Jan. 19, 1933, pp. 73–77. History and description of activities; geodetic control surveys; hydrographic surveys; tides and tidal planes; triangulation at sea by radio-acoustic ranging; terrestrial magnetism and seismology studies; tide-predicting machine.

TUNNELS

VEHICULAR, OREGON. Highway Location Problem Solved by Tunnel, E. A. Collier. *Eng.-News-Rec.*, vol. 110, no. 3, Jan. 19, 1933, p. 85. Construction of concrete-paved, timber-lined bore, 1,085 ft long, saving a distance of 4 miles on the connecting link between the main Pacific Coast highways in Oregon; cost data.

WATER RESOURCES

OREGON. Geology and Ground-Water Resources of Dalles Region, Oregon, A. M. Piper. *U.S. Geol. Survey Water-Supply Paper*, 659-B, 1932, pp. 107–189, supp. plates. 25 cents. Report on the investigation conducted in cooperation with the Oregon State Agricultural Experiment Station to determine the feasibility of pumping water from wells for irrigating tracts at The Dalles, Ore.; area covers 300 sq miles; stratigraphy, structure, geologic, and physiographic history; chemical character of ground water; well and spring data.

WATER SUPPLY, UNDERGROUND. Methods for Estimating Ground-Water Supplies, O. E. Meinzer. *Water and Water Eng.*, vol. 34, no. 411, Dec. 20, 1932, pp. 604–606. Estimating intake from surface streams and directly from rain and melting snow; estimating discharge by overflow, evaporation from soil and transpiration from plants; storage methods in general; specific yield in relation to storage methods; estimating discharge from daily fluctuations of water table; method based on ground-water rating curve. (To be continued.)

WATER TREATMENT

ANALYSIS. Procedure for Making Odor and Taste Determinations. *Water Works and Sewerage*, vol. 79, no. 12, Dec. 1932, pp. 425 and 426. Review of American practice; making determination; determining threshold point. Bibliography.

CHLORINATION. How St. Cloud Combined Use of Activated Carbon with Ammonia-Chlorine Process, C. L. Ehrhart. *Water Works Eng.*, vol. 86, no. 1, Jan. 1933, pp. 16–18. Methods used and results obtained at St. Cloud, Minn., with water from the Mississippi River; ammonia and chlorine feed; after-growths and algae; bleaching effect on increase in chlorine; bacterial reduction; reduction in filter sand. Before Am. Water Works Ass'n.

COLOR REMOVAL. Decolorizing Cape Town Water. *Water and Water Eng.*, vol. 34, no. 411, Dec. 20, 1932, pp. 602 and 603. Program of tests for experimental plant established by municipality of Cape Town, South Africa.

ELECTRIC. Electrical Water Sterilization, T. Rich. *Elec. Rev.*, vol. 111, no. 2874, Dec. 23, 1932, p. 918. In France rapid progress has been made with this simple system; fresh air is drawn through high-frequency ozone generator, and then intimately mixed with water to be purified in special form of injector; excess ozone is discharged by passing water over a series of weirs; water is then potable, microbes having been burnt up by ultra-active oxygen.

FILTRATION PLANTS, OPERATION. Some Practical Suggestions to Operators Concerning When and How to Wash a Filter, A. V. Graf. *Water Works Eng.*, vol. 85, no. 26, Dec. 28, 1932, pp. 1516, 1517, and 1540. Proper head at which filter should be washed; proper procedure in washing filter; operator must watch filter when washing; removal of mud balls. Before Missouri Water and Sewerage Conference.

SEDIMENTATION. Settling Velocity—Theory and Experiments, K. Tsurumi. *Civ. Eng. Soc. Japan—Journal*, vol. 18, no. 10, Oct. 1932, pp. 1059–1094. Review of international literature on subject; results of original laboratory experiments. (In Japanese.)

TASTE AND ODOR REMOVAL. Powdered Activated Carbon in Water Purification, F. E. Stuart. *Can. Engr.*, vol. 64, no. 1, Jan. 3, 1933, pp. 19–21. Removal of tastes and odors by use of Nuchar; technic of application; history of use of carbon; carbon dosage. Before New England Water Works Ass'n.

WATER WORKS ENGINEERING

LAWS AND LEGISLATION. Recent Interpretations by Higher Courts of Law of Water Works Construction, L. T. Parker. *Water Works Eng.*, vol. 85, no. 26, Dec. 28, 1932, pp. 1525–1527. Public officials not personally liable for payments for defective work; contracts must be let to lowest bidder; city not liable on implied contract; warrants for payment held valid; when contractor is entitled to recover deposit; right to refuse to employ aliens; architect liable for defective construction.

MATERIALS. Ammonium Sulfate Specifications for Water Purification Plant, A. G. Nolte and W. A. Kramer. *Water Works Eng.*, vol. 85, no. 26, Dec. 28, 1932, p. 1540. Purchasing policy and specifications adopted by St. Louis Water Department, which is considered the largest buyer of this material.

RATE MAKING. Elements Entering Into Formation and Revision of Water Rate Structures, R. E. McDonnell. *Water Works Eng.*, vol. 85, no. 26, Dec. 28, 1932, pp. 1522–1524. Fundamental rate consideration; reasons for rate changes; water rates outside city; comparison of rates with other cities; water consumption in rate making. Before Am. Water Works Ass'n. (To be concluded.)

RECENT DEVELOPMENTS. Developments in Water Supply and Treatment During the Past Year, N. J. Howard. *Contract Rec.*, vol. 46, no. 52, Dec. 28, 1932, pp. 1442–1447. Developments in Canada; recent accomplishments in the United States; new undertakings in Europe; trends in filtration practice; new filtration equipment; corrosion studies; pipe linings and paints. (To be continued.)

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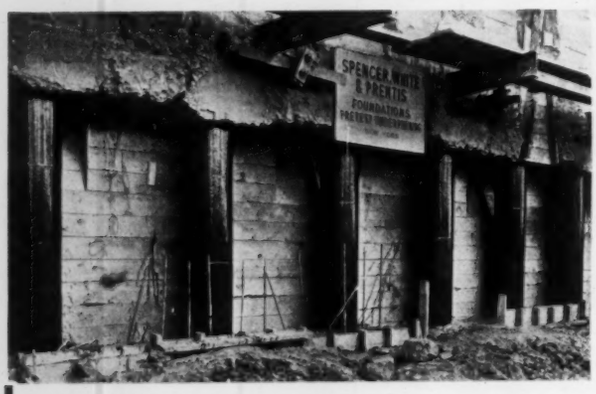

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